QIL Ridgeway.
X5730

INSTRUCTION MANUAL
SERIES X-2
DIGITAL VOLTMETER

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

NOTICE

If at any time it should become necessary to return an NLS instrument to the factory, follow the instructions contained in the Appendix of this manual (page A-1) and utilize NLS Form No. 200-50 (Shipping Notice/Packing Slip), located at the rear of the manual.

Document No. 837
Revision D
April 1969

INSTRUCTION MANUAL
SERIES X-2
DIGITAL VOLTMETER

DIGITAL VOLTMETER SERIES X-2
-03.838 DC
KΩ
AC
DC
MV
1 10 100 1000 10000
AUTO
OFF REMOTE ON
MV DC AC KΩ
HI
LO
NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

Originator of the Digital Voltmeter
non-linear systems, inc.
DEL MAR, CALIFORNIA

Printed in the United States of America

Entire contents copyright, 1969. No part of this book
may be reproduced without written permission from
Non-Linear Systems, Inc., Del Mar, Calif.

CAUTION

WHEN THE INSTRUMENT DESCRIBED IN THIS MANUAL IS INSTALLED IN A SERIES X-1-TYPE OUTER CHASSIS (FOR SYSTEM APPLICATION), REMOVE CABLE CONNECTIONS PRIOR TO REMOVING THE INSTRUMENT DRAWER ASSEMBLY FROM THE CHASSIS. FAILURE TO OBSERVE THIS PRECAUTION MAY CAUSE DAMAGE TO CABLE AND INSTRUMENT CONNECTORS.

TABLE OF CONTENTS

Chapter	Title	Page
I	INTRODUCTION AND SPECIFICATIONS	1-1
	Optional Function Accessories	1-1
	General	1-1
	Operating Principle	1-1
	Digital Output	1-1
	Floating Input	1-1
	Common-Mode-Rejection	1-1
	Procedure to Determine CMR	1-2
	Specifications	1-2
II	INSTALLATION AND OPERATION	2-1
	Unpacking	2-1
	Mounting	2-1
	Power Source	2-1
	Fusing	2-1
	Power Grounding	2-1
	Connectors (S/N's X-2. 1 thru X-2. 156)	2-1
	Connectors (S/N's X-2. 157 & Subsequent)	2-2
	Cable Connections	2-2
	Controls	2-2
	Power Switch (S/N's X-2. 1 thru X-2. 156)	2-2
	Power Switch (S/N's X-2. 157 & Subsequent)	2-2
	Remote Triggering (S/N's X-2. 157 & Subsequent)	2-2
	Range Switch	2-4
	Operating Cautions	2-5
	Function Switch	2-7
	Offset Controls	2-7
	Digital Readout	2-7
III	CALIBRATION	3-1
	Scope	3-1
	DC Voltage Calibration	3-1
	Equipment Required	3-1
	Initial Preparation	3-1
	Procedure	3-1
	Reference Adjustment	3-1
	Zero Offset Adjustment	3-2
	10-Volt Range Calibration for Positive Input	3-2

TABLE OF CONTENTS (CON'T)

Chapter Title Page

III CALIBRATION (Cont'd)

10-Volt Range Calibration for Negative Input 3-4
100-Volt Range Calibration 3-4
1000-Volt Range Calibration 3-5
AC Converter Calibration 3-5
Additional Equipment Required 3-5
Initial Preparation 3-5
Procedure 3-5
Ohms Converter and Pre-Amplifier Calibration 3-6
Additional Equipment Required 3-6
Initial Preparation 3-6
Procedure 3-6
Precision Pre-Amplifier Calibration 3-7
Initial Preparation 3-7
Procedure 3-7

IV MAINTENANCE 4-1

Digital Readout Replacement 4-1
Troubleshooting 4-12
Fan Lubrication 4-1

V RECOMMENDED SPARE PARTS LIST 5-1

APPENDIX A-1

LIST OF TABLES

Number Title Page

I Measurement Capabilities 2-7
II Troubleshooting 4-12

LIST OF ILLUSTRATIONS

Figure Title Page

1-1 Connections to Determine CMR 1-3
1-2 Series X-2 DVM Outline Drawing 1-3
2-1 Power Plug Pin Coding 2-2
2-2 Front Views 2-3
2-3 Rear Views 2-3

LIST OF ILLUSTRATIONS (CONT)

Figure Title Page

2-4 Input Connections 2-4
3-1 Cover Removal 3-2
3-2 Location of Major Subassemblies & Adjustment Points 3-3
3-3 Reference Adjustment 3-4
3-4 Precision Pre-Amplifier Assembly Adjustment Points 3-8
4-1 Block Diagram Series X-2 DVM 4-2
4-2 Simplified Diagram, Auto-Ranging 4-3
4-3 Simplified Diagram, Reference Supply 4-4
4-4 Simplified Diagram, Series X-2 Input-Integrator with Resetter Circuitry and Temperature Compensation Potentiometers 4-5
4-5 Simplified Diagram, AC Converter 4-6
4-6 Simplified Diagram, Pre-Amplifier 4-7
4-7 Simplified Diagram, Ohms Converter 4-7
4-8 Type SN7490N Decade Counter 4-8
4-9 Type SN7473N Dual J-K Master-Slave Flip-Flop 4-8
4-10 Type SN7474N Dual D-Type Edge-Triggered Flip-Flop 4-9
4-11 Type SNX7441N BCD-to-Decimal Decoder/Driver 4-9
4-12 Type SN7472N JK Master-Slave Flip-Flop 4-10
4-13 Type SN7400N Quadruple 2-Input Positive Nand Gate 4-10
4-14 Type SN7430N 8-Input Positive Nand Gate 4-10
4-15 Type SN7475N Quadruple Bistable Latch 4-11

LIST OF SCHEMATIC DIAGRAMS

Dwg. No. Title

37-30, "B" Change Decade Assembly
" " "D" Change Decade Assembly
37-36 Reference Assembly
37-39 Attenuator Assembly
37-69 Start/Stop Assembly
37-72 Main Board & Power Supply Assembly
37-105 Main Board & Power Supply Assembly
37-160 Decade Assembly
37-272 Reference Assembly
37-272, "A" Change Reference Assembly
37-275, "A" Change Attenuator Assembly
37-275, "C" Change Attenuator Assembly
37-275, "D" Change Attenuator Assembly
37-298 Main Board & Power Supply Assembly
37-360 Decade Assembly

LIST OF SCHEMATIC DIAGRAMS (CON'T)

Dwg. No.	Title
36-658	MV Converter Assembly
37-33	Start/Stop & Auto Range Assembly
37-42	Pre-Amplifier & KΩ/DC Converter Assembly
37-45	AC/DC Converter Assembly (10K Hz)
37-77	AC/DC Converter Assembly (100K Hz)
37-89	Print Board Assembly
37-278,"A" Change	Pre-Amplifier & KΩ/DC Converter Assembly
37-278, "E" Change	Pre-Amplifier & KΩ/DC Converter Assembly
37-281	AC/DC Converter Assembly (10K Hz)
37-315	AC/DC Converter Assembly (100K Hz)
37-316	Print Board Assembly

CHAPTER I

INTRODUCTION AND SPECIFICATIONS

The NLS Series X-2 Digital Voltmeter is a three-range, four-digit instrument with automatic polarity and with provisions for 20% over-ranging on the two lowest ranges. An automatic ranging feature is offered as an option. The instrument may be used as a bench model or, with the use of rack-mounting adapters, may be rack-mounted in a standard 19-inch mounting rack.

OPTIONAL FUNCTION ACCESSORIES

In addition to measuring DC voltages, the Series X-2 DVM is capable of measuring AC voltages, millivolts and ohms. These extra features may be obtained by utilizing optional plug-in modules. A K Ohms converter/pre-amplifier provides ohms and millivolt measurements or a precision pre-amplifier provides higher accuracy in millivolt measurements, and one of two types of AC converters (50 Hz to 10K Hz or 50K Hz to 100K Hz) provides AC voltage measurement.

GENERAL

The Series X-2 Digital Voltmeters are solid state integrating instruments that measure the absolute value of DC voltages or the integral of varying voltages. In these instruments the unknown input voltage is converted to a pulse train whose repitition rate is directly proportional to input voltage magnitude. The total number of pulses generated over a clocked 0.1 second interval is counted electronically and displayed as the voltage value.

OPERATING PRINCIPLE

An input of 10 volts to the instrument creates 10,000 pulses in 0.1 second; this is displayed as 10.000 volts. If the input voltage changes during the measuring interval, the pulse repetition rate changes proportionately, and the total number of pulses that occurs during the 0.1 second sample period is a measure of the number of volt-seconds at the input. Since these instruments mathematically integrate the input voltage, they are useful for obtaining the velocity from a voltage which is proportional to acceleration. In addition, these instruments are inherently able to reject sinusoidal ripple because the integrated value of an integral number of sine waves is zero. Therefore if an integral number of cycles of sine wave noise occurs during the 0.1-second sampling interval, its contribution to the overall reading is "integrated out".

DIGITAL OUTPUT

Beginning with serial number X-2.157, the instrument possesses a printout and remote triggering capability for operation with data printers, tape punches, typewriters and other recording devices. For printout, the Print Board Assembly, with pendant cable and connector is offered as an option.

FLOATING INPUT

Because input signal leads may be disconnected from the Series X-2's outer chassis (by removing a shorting strap between J5 and J6 on the rear of the instrument), signal-to-chassis potentials up to 500 volts are permissible. Floating input adds to the DVM's versaltility by permitting it to measure voltage sources which could not be accurately measured by a non-isolated meter.

COMMON-MODE-REJECTION

Rejection of common-mode signals, those

caused by AC or DC currents flowing between signal source ground and instrument chassis ground is a feature of the Series X-2 DVM. (To obtain CMR, the shorting strap described in the above paragraph must be removed.) Common-mode signal rejection is important in a wide range of applications - testing complex electrical and electronic systems, in automatic measuring systems, and measuring outputs from thermocouples, strain gages and other transducers where common-mode signals may be many times greater than the measured DC voltage.

PROCEDURE TO DETERMINE CMR

1. Turn the X-2 DVM on and allow 30 minutes for warm-up.

2. Remove shorting strap between J5 and J6.

3. Connect DVM to signal source and common-mode source as shown in Figure 1-1. Signal source is preferably a series string of three or four 1.5V batteries (flashlight cells or 1.3V mercury cells). To obtain an accurate measurement of CMR, the source resistance of the signal source should be less than 10 ohms. The output of a variac, connected as shown in Figure 1-1, will adequately provide the required common-mode source.

4. Set variac to zero volts then advance variac in voltage until a one digit "bobble" is observed in the least significant decade then, back off variac until "bobble" just stops. Measure the variac output with an AC voltmeter and convert to peak-to-peak voltage.

5. To obtain rejection ratio, divide peak-to-peak common voltage by 1 MV.

$$\text{Common-mode rejection radio} = \frac{E_{p-p}}{10^{-3}}$$

$$DB = 20 \log \frac{E_{p-p}}{10^{-3}}$$

$$DB = 20 \log 1{,}000\ E_{p-p}$$

6. For example, if the common-mode voltage is 3.5V

$$E_{p-p} = 3.5 \times 2.828$$

$$E_{p-p} = 10V \text{ and}$$

$$DB = 20 \log 1{,}000 \times 10$$

$$DB = 20 \log 10^4$$

$$DB = 20 \times 4 = 80$$

Common-mode rejection = 80 DB

The NLS Sales Representative or Engineering Department will be pleased to assist you with specific application problems and, of course, will gladly welcome your comments and suggestions.

SPECIFICATIONS

CIRCUITRY:	All solid state.
ANALOG-TO-DIGITAL CONVERSION:	Bi-polar integrator.
FULL SCALE DC RANGES:	±9.999, ±99.99, ±999.9 with 20% over-range on the two lower ranges.

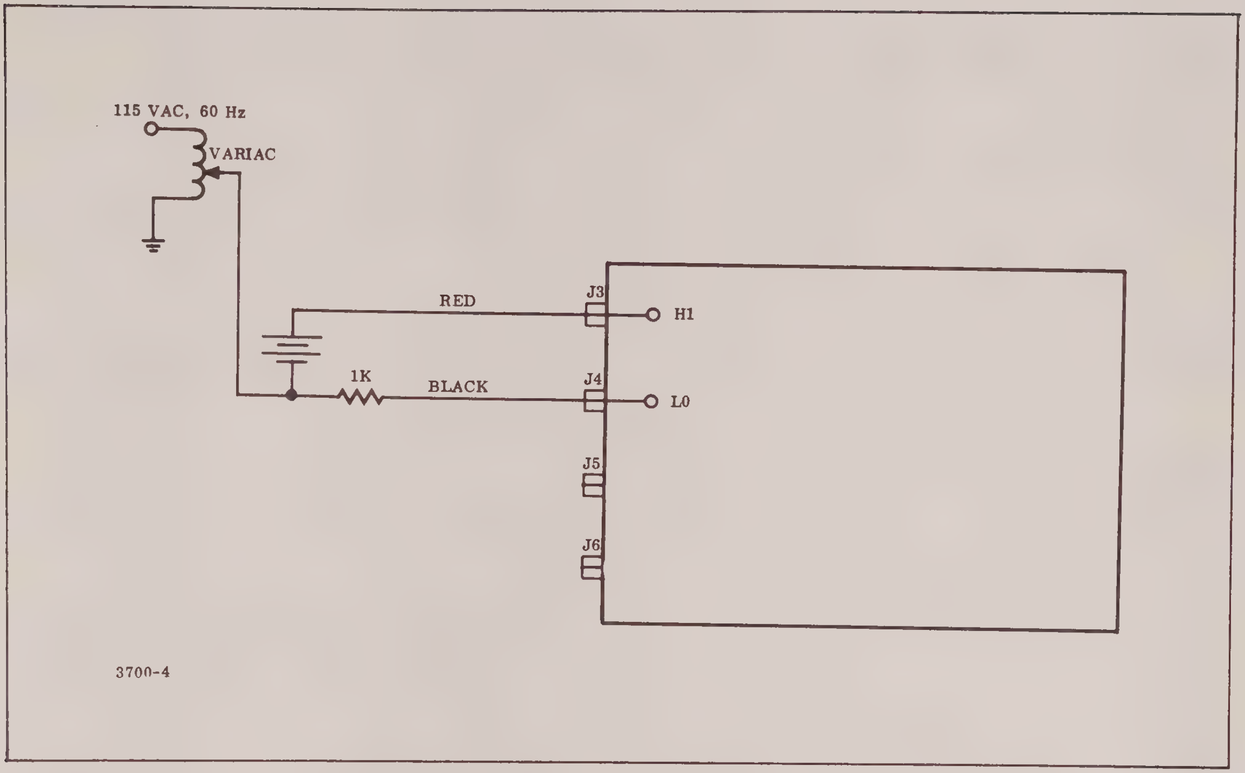

115 VAC, 60 Hz
VARIAC
RED
1K
BLACK
J3
J4
J5
J6
H1
L0
3700-4

Figure 1-1. Connections to Determine CMR

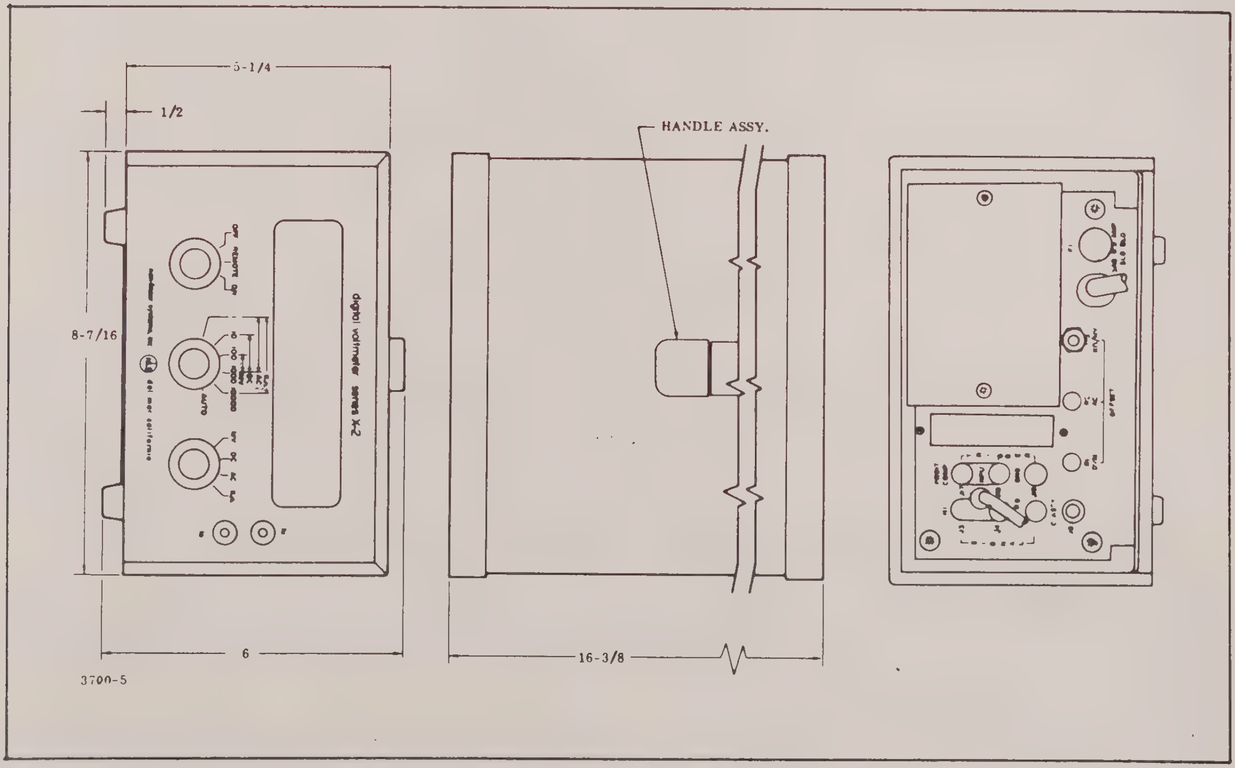

5-1/4
1/2
8-7/16
6
HANDLE ASSY.
16-3/8
digital voltmeter series X-2
del mar california
3700-5

Figure 1-2. Series X-2 DVM Outline Drawing

ACCURACY AT ASA REFERENCE CONDITIONS:	±0.01% of full scale ±0.02% of reading.
RESOLUTION:	One digit.
RESPONSE TIMES:	Voltage-to-Frequency Converter Settling Time - 100 MS (with filter). Digitizing Time - 100 MS. Range Selection Time - 100 MS.
INPUT RESISTANCE:	10 megohms, constant all ranges, except when 20% over-range is exceeded.
COMMON-MODE-REJECTION:	100 DB @ DC; 80 DB @ 60 Hz -- 1KΩ unbalance
RANGE SELECTION:	Manual or Automatic/Manual (see options).
POLARITY SELECTION:	Automatic.
INPUT CONNECTIONS:	Front and rear. Input may be floated ±500 volts above chassis by removing shorting strap from rear input connectors.
AMBIENT TEMPERATURE:	Extreme - 12° C to 50° C.
POWER REQUIREMENTS:	105/125 VAC, 50/420 Hz.
MOUNTING POSITION:	Any.
WEIGHT:	15 pounds
SIZE:	5-1/4 inches (excluding feet and handle) x 8-7/16 inches x 16-3/8 inches.
OPTIONS AVAILABLE:	Automatic ranging.
ACCESSORIES AVAILABLE:	AC/DC Converters K Ohms/DC Converter and Pre-Amplifier Precision Pre-Amplifier Print Board Assembly - BCD 8-4-2-1 Logic "0" = 0 volt to +0.5 volt, Logic "1" = +3 volts ±0.1 volt Rack Mounting Adapters

AC/DC Converter, Types I and II for X-2

RANGES; including 20% over-range	1.1999/11.999 119.99 & 500.00 VAC
FREQUENCY RESPONSE	10K Hz 100K Hz Lower frequency converters are available on special order. The 10K Hz converter is usable to 30 K Hz in the manual ranging mode.

ACCURACY:	10K Hz	0.05% reading + 0.02% FS, 200 Hz to 3K Hz, 1000 VAC 0.1% reading + 0.05% FS, 50 Hz to 200 Hz and 3K Hz to 10K Hz, 1000 VAC 30 Hz accuracy is typically 0.3%
	100K Hz	Same as 10K Hz, plus: 0.3% reading + 0.1% FS, 10K Hz to 30K Hz, 500 VAC 0.5% reading + 0.1% FS, 30K Hz to 100K Hz, 150 VAC
RESPONSE TIME		600 milliseconds to 0.1% of final value
INPUT IMPEDANCE		One megohm, shunted by 100 PF
RANGING		Automatic and manual

Ohms/DC Converter

ACCURACY	Four Digit	Maximum Current
±0.01% FS and ±0.02% reading (1KΩ, 10KΩ, 100KΩ and 1000K ranges)	1.19999KΩ	10 MA
	11.999KΩ	1 MA
	119.99KΩ	100 μA
	1199.9KΩ	10 μA
±0.01% FS ±0.1%	11,999.KΩ	1 μA

STABILITY	0.05% full scale for at least 90 days on all ranges
RESPONSE TIME	100 milliseconds for step response. 200 milliseconds for step response with range change. 700 milliseconds on 10 megohm range
RANGING	Automatic and manual (Manual only 10,000K Range)
INPUT CONFIGURATION	Two wire with voltage protection

Automatic Ranging DC Preamplifier

RANGES	X10	±000.1 MV to ±1199.9 MV
	X100	±00.01 MV to ±119.99 MV
ACCURACY	X10	±0.02% reading and ±0.01% Full Scale
	X100	±0.05% reading and ±0.05% Full Scale
GAIN STABILITY		0.01% for at least 30 days
ZERO STABILITY		Drift does not exceed ±50μV or ±5 digits, whichever is greater, for at least seven days at constant temperature.
INPUT INPEDANCE		Greater than 100 megohms
RESPONSE TIME		500 MS for step response to 0.01%

Precision Pre-Amplifier

RANGES:	119.99/1199.9 MVDC
ACCURACY UNDER ASA REFERENCE CONDITIONS:	±(0.01% of reading + 0.01% of full scale)
STABILITY:	Short Term: ±(0.01% of full scale) Long Term: See Rated Accuracy
RESPONSE TIME:	Step to 0.01% of final value: 1 second* Each range change to 0.01% of final value: 1 second*
INPUT CHARACTERISTICS:	Resistance, Steady State: 100 MΩ minimum Resistance, Dynamic: 20 KΩ minimum

* Response time is considerably increased for signals whose source resistance is higher then 10 KΩ.

Specifications are Subject to Change Without Notice

CHAPTER II

INSTALLATION AND OPERATION

UNPACKING

The instrument is shipped in a heavy cardboard container. Cut the tape on the top of the container and open. If damage is seen, promptly notify the carrier.

MOUNTING

The instrument was primarily designed as a bench instrument, however, three types of mounting adapters for mounting in a standard 19-inch mounting rack are available at customer's option. One type may be obtained with an additional drawer for storage of tools, spare parts, etc; a second type will accommodate two Series X-2 DVM's; and the third type is a 19-inch front panel attached to the instrument.

CAUTION

> Do not operate the instrument before ensuring that each plug-in board is firmly in place. Failure to take this precaution may cause damage to components on the board assemblies.

POWER SOURCE

Instruments bearing S/N's X-2.1 thru X-2.462 were usually supplied for operation from 110-120 volt, 50-60 Hz, single phase power sources. Instruments bearing S/N's X-2.463 and subsequent operate from 110-120 volts, 50-420 Hz, single phase power sources. All instruments will operate from 220-230 volt sources if the two primaries of the power transformer are wired in series instead of in parallel. The ventilating fan (S/N's X-2.157 thru X-2.462 and others so modified) must be rated at the correct voltage. The Serial No. tag at the rear of the instrument indicates the correct power source if other than 110-120 volts.

FUSING

The instrument is protected by a 3AG one-half ampere fuse which is located in an extractor post on the rear panel. When a 220-230 volt power source is to be used (and the power transformer primary rewired as indicated above), it is recommended that a one-fourth ampere fuse be used to provide maximun protection.

POWER GROUNDING

The third pin of the power plug grounds the outer chassis of the instrument (Figure 2-1). Despite the presence of the third grounding pin, there is no real assurance that the instrument will be correctly connected since the power outlets in many installations are erroneously wired. Be certain that the power source is in agreement with the power and grounding requirements of the instrument.

CONNECTORS (S/N's X-2.1 thru X-2.156)

Two input connectors (J1 and J2, labeled HI and LO respectively) are located on the front panel of the instrument (Figure 2-2) and are wired in parallel with two connectors (J3 and J4) located on the rear of the instrument (Figure 2-3). Two additional connectors (J5 and J6) are located on the rear of the unit and under normal operating conditions are connected together with a shorting strap. To float the input above chassis ground (up to ±500 volts), the shorting strap must be removed.

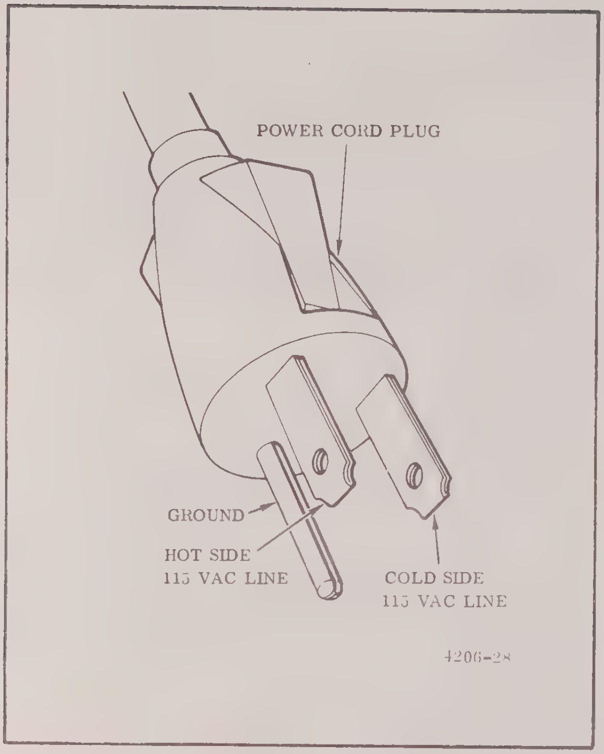


Figure 2-1. Power Plug Pin Coding

CONNECTORS (S/N's X-2.157 & subsequent)

These instruments have the same input connectors as those described in the above paragraph and inaddition, have three remote triggering connectors (J17, J18 and J19) installed on the rear panel. If the printout option is elected, digital output connector J7 is also installed on the rear panel (see Print Board Assembly Schematic Diagram for connector pin information).

CABLE CONNECTIONS

The instrument is supplied with an input cable (P/N 2963-C - 36) for insertion into J1 and J2 on the front panel or J3 and J4 on the rear panel. See Figure 2-4 for connection information. A mating connector is supplied for J7 when the printout capability option is elected.

CONTROLS

POWER SWITCH (S/N X-2.1 thru X-2.156)

The power switch is located on the front panel of the instrument and has three positions (OFF, STBY. and ON). The STBY. position is used to stop the instrument from taking further readings. The ON position commands the instrument to take readings at its maximum rate (allow 30 minutes for instrument warm-up).

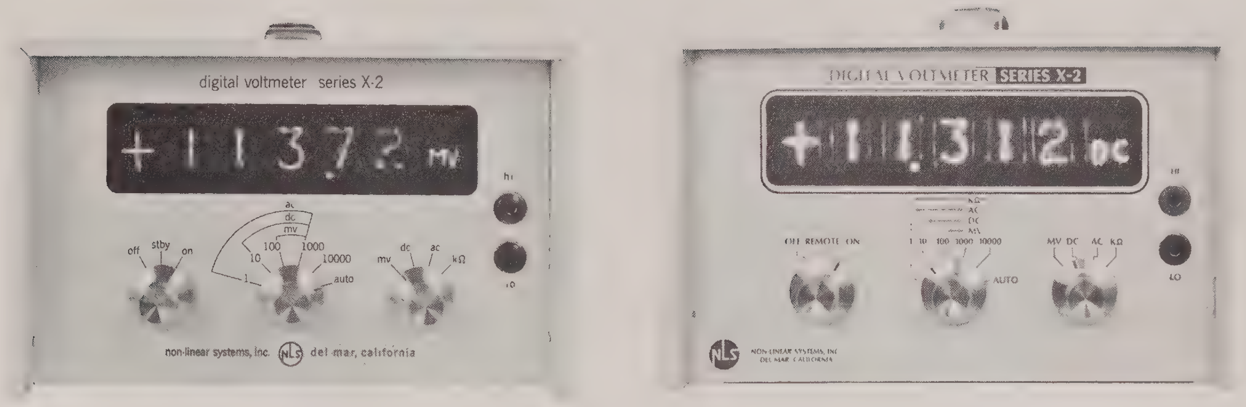
POWER SWITCH (S/N's X-2.157 & subsq.)

The STBY. position of the power switch on these instruments has been re-labeled REMOTE. In the REMOTE position, a print/record pulse is issued at the completion of each measurement; in the ON position this pulse is inhibited. In the absence of a remote triggering pulse, the REMOTE position serves as a standby control, i.e., the last reading taken remains stored in the readout.

REMOTE TRIGGERING (S/N's X-2.157 & subsequent)

To externally trigger the instrument by a recording device through connector J7, the shorting strap between connectors J17 and J18 must be kept in place. Each pulse applied through connector will provide only a single reading. For each pulse applied, a delay of 180 MS will take place in the VDC, MVDC and K ohms functions and a delay of 900 MS will take place in the AC function.

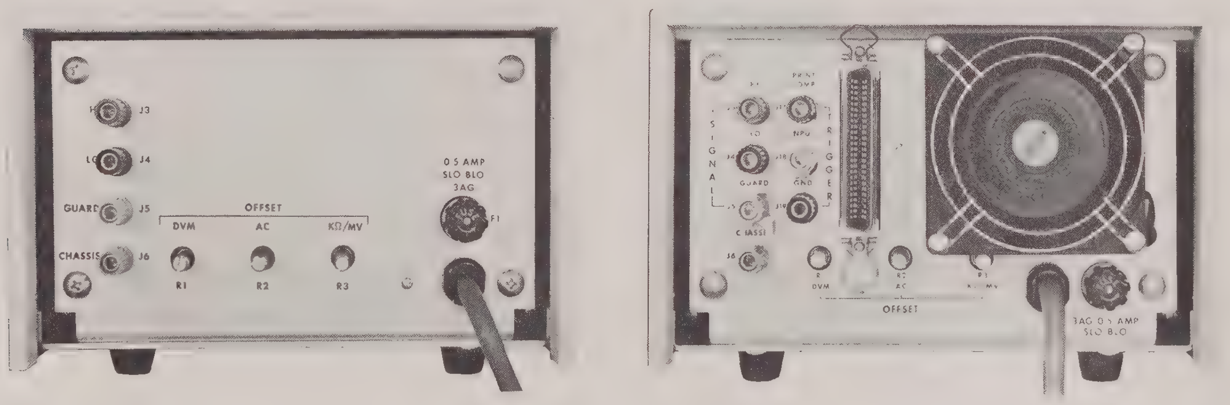
With the shorting strap between connectors J17 and J18 removed, the instrument may also be externally triggered by a contact closure between connectors J18 and J19. For a single reading only, the duration of this


digital voltmeter series X-2
+11372 mv
hi
lo
off stby on
ac dc mv
1 10 100 1000 10000 auto
mv dc ac kΩ
non-linear systems, inc. NLS del mar, california
DIGITAL VOLTMETER SERIES X-2
+11.312 DC
HI
LO
OFF REMOTE ON
KΩ AC DC MV
1 10 100 1000 10000
AUTO
MV DC AC KΩ
NLS NON-LINEAR SYSTEMS, INC DEL MAR CALIFORNIA

S/N's X-2.1 THRU X-2.156

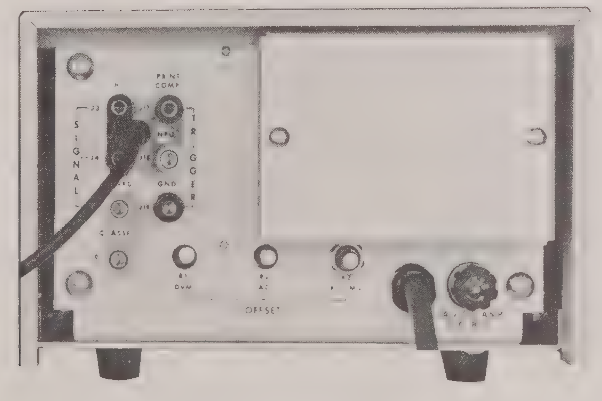
S/N's X-2.157 & SUBSEQUENT

Figure 2-2. Front Views


HI J3
LO J4
GUARD J5
CHASSIS J6
OFFSET
DVM AC KΩ/MV
R1 R2 R3
0.5 AMP SLO BLO 3AG
F1
SIGNAL
GUARD
TRIGGER
NPU
GND
OFFSET
DVM AC
3AG 0.5 AMP SLO BLO

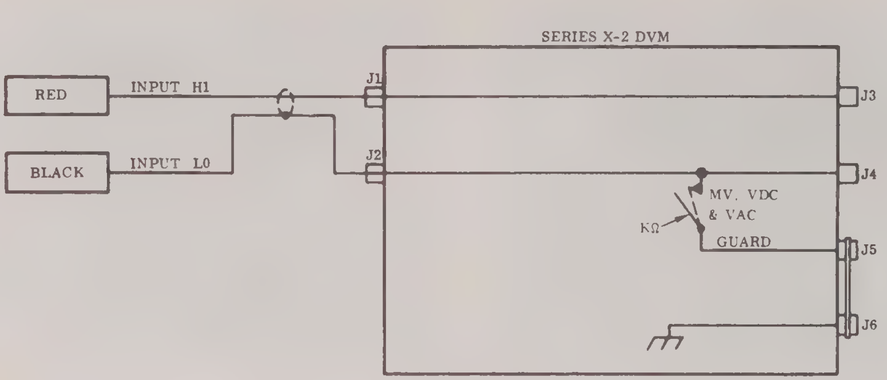
S/N's X-2.1 THRU X-2.156

S/N's X-2.157 THRU X-2.462


PRINT COMP
SIGNAL
TRIGGER
NPU
GND
OFFSET

S/N's X-2.463 & SUBSEQUENT

Figure 2-3. Rear Views



CAUTION

TO AVOID DAMAGING THE INSTRUMENT, REMOVE THE SHORTING STRAP BETWEEN J5 AND J6 WHEN FLOATING INPUT ABOVE CHASSIS GROUND AND, WHEN IN THE KΩ FUNCTION:

1. DO NOT CONNECT A SHORTING STRAP BETWEEN J4 AND J5
2. REMOVE THE SHORTING STRAP BETWEEN J5 AND J6 WHEN MEASURING GROUNDED RESISTORS
3. DO NOT TOUCH THE INPUT LO LEAD TO EARTH, GUARD, OR CHASSIS WHEN THE SHORTING STRAP IS BETWEEN J5 AND J6.

3700-1

Figure 2-4. Input Connections

closure must be less than 100 MS. Closures in excess of 100 MS (with the exception of range changes) will cause the instrument to continuously scan as long as the closure is applied.

To eliminate first-reading-error with either method of triggering, the input signal to be measured must be applied prior to the application of the triggering pulse.

RANGE SWITCH

The range switch is located on the front panel of the instrument and has six positions. (See table I.) When in the 1 position, the instrument is locked in the 1 volt range for the measurement of AC voltages or in the 1K range for the measurement of K ohms. When in the 10 position, the instrument is locked in the 10-volt range for the measurement of AC or DC voltages or in the 10K range for the measurement of K ohms. When in the 100 position, the instrument is locked in the 100-volt range for the measurement of AC and DC voltages, in the 100 MV range for the measurement of millivolts or in the 100K range for the measurement of K ohms. When in the 1000 position, the instrument is locked in the 1000-volt range for the measurement of AC and DC voltages, in the 1000 MV range for the measurement of millivolts or in the 1000KΩ range for the measurement of K ohms. When in the 10,000 position, the instrument is locked in the 10,000KΩ range for the measurement of K ohms. If the instrument has the automatic ranging capability, the proper range is automatically selected when the switch is in the AUTO position. (The 10,000KΩ range can only be selected manually.) With the switch in the AUTO position (if the instrument does not have the auto-ranging capability), the readout will not display decimals and the instrument will be in the lowest range of the particular function selected by the function switch.

OPERATING CAUTIONS

GROUND REFERENCE MEASUREMENTS

When measuring an AC power line, or any potential where one side is reference to earth ground, first remove the shorting strap between guard and chassis ground (J5 and J6) on the rear of the instrument. The guard connects to signal low inside the unit. If signal low (J2) is inadvertently connected to the power line "hot" lead, it will be shorted to ground due to internal circuitry and the instrument will be damaged.

OHMS MEASUREMENT

1. Input low is NOT connected to guard (KΩ mode only). DO NOT therefore connect shorting strap between input low and guard (J4 and J5).
2. If input low lead is allowed to contact earth, guard or chassis with strap between guard and chassis (J5 and J6), fuse on KΩ Converter will blow.

EXTERNAL TRIGGERING

When externally triggering the DVM through pin 47 of connector J7, DO NOT apply an input voltage in excess of 5 volts. Failure to observe this precaution may result in damage to the instrument.

Table I. Measurement Capabilities

		Range Switch Positions					
		1	10	100	1000	10,000	AUTO
Function Switch Positions	MV	☒	☒	100 MV RANGE	1000 MV RANGE	☒	100 MV or 1000 MV RANGES
	DC	☒	10 VDC RANGE	100 VDC RANGE	1000 VDC RANGE	☒	10 VDC, 100 VDC, or 1000 VDC RANGES
	AC	1 VAC RANGE	10 VAC RANGE	100 VAC RANGE	1000 VAC RANGE (500 VAC MAX.)	☒	1 VAC, 10 VAC 100 VAC or 1000 VAC RANGES (500 VAC Max)
	KΩ	1KΩ RANGE	10KΩ RANGE	100KΩ RANGE	1000KΩ RANGE	10,000KΩ RANGE	ALL EXCEPT 10,000KΩ RNG.

NOTE: The combined positions of the range and function switches as indicated by ☒ above will produce erroneous readings.

FUNCTION SWITCH

The function switch is located on the front panel of the instrument and has four positions. (See Table I.) It is used to select the desired measurement function, either MV, DC, AC or KΩ.

OFFSET CONTROLS

Three screwdriver-adjust potentiometers are located on the rear of the unit. They are provided to zero the reading of the instrument in each of its measuring functions. The specific use of these controls is described in the calibration instructions.

DIGITAL READOUT

The instrument is normally supplied with six readout tubes: polarity display; overrange display; and four 0 thru 9 digital and decimal displays (left to right respectively).

A function tube (displaying MV, DC, AC or KΩ) is offered as an optional accessory and when utilized is located on the extreme right of the readout. The polarity display (S/N's X-2.307 and subsequent) also indicates an overload condition, i.e., when the input exceeds the limits of a particular manually selected range, the left-most readout tube will display OL. With the range switch in the AUTO position, the overload display will only illuminate when the extreme limits of the instrument have been reached. Refer to specifications for limits of each measurement function.

NOTICE

If at any time it should become necessary to return an NLS instrument to the factory, follow the instructions contained in the Appendix of this manual (page A-1) and utilize NLS Form No. 200-50 (Shipping Notice/Packing Slip), located at the rear of the manual.

CHAPTER III

CALIBRATION

In the calibration instructions provided in this chapter, it is assumed, that the instrument is in good working order and only requires calibration. If any components are defective, it may be difficult, if not impossible, to calibrate the instrument.

SCOPE

The basic DC calibration procedure is divided into six distinct areas: reference adjustment; zero offset adjustment; 10-volt range calibration for a positive input; 10-volt range calibration for a negative input; 100-volt range calibration; and 1000-volt range calibration.

Since the Series X-2 instruments are capable of millivolts, AC and ohms measurements, calibration procedures for these functions are also included.

DC VOLTAGE CALIBRATION

EQUIPMENT REQUIRED

1. A voltmeter capable of measuring -20 VDC (±1 MVDC).
2. An extension board, NLS No. 1009-41.
3. A voltage standard between 9.000 volts and 11.998 volts.
4. A voltage standard between 90.00 volts and 119.98 volts.
5. A voltage standard between 900.0 volts and 1000.0 volts.

NOTE

It should be noted that the error in making a measurement with the Series X-2 DVM can be as much as the stated accuracy of the instrument plus the accuracy of the voltage standards used in its calibration.

INITIAL PREPARATION

1. Remove the cover of the instrument by removing the four screws (two on each side) attaching the cover to the chassis (Figure 3-1).
2. Plug the power cord into a 115 VAC, 50-60 Hz, single phase power source.
3. Place the power switch in the STBY. position and allow 30 minutes for instrument warm-up.

PROCEDURE

Reference Adjustment

1. Remove the reference assembly, from instrument (Figure 3-2).
2. Insert extension board into J12 main board assembly.
3. Mount reference assembly on top of extension board by inserting reference board pins into extension board. Use care to ensure proper pin alignment.
4. Connect a voltmeter capable of measuring -20 VDC (±1 MVDC) between ground and -20V output, pin 33 and pin 39 (Figure 3-3).
5. Adjust R1 (Figure 3-3) on reference assembly until test meter reads -20V (±1 MVDC).

Remove reference assembly from extension board and remove extension board from instrument.

7. Insert reference assembly into J12.

Zero Offset Adjustment.

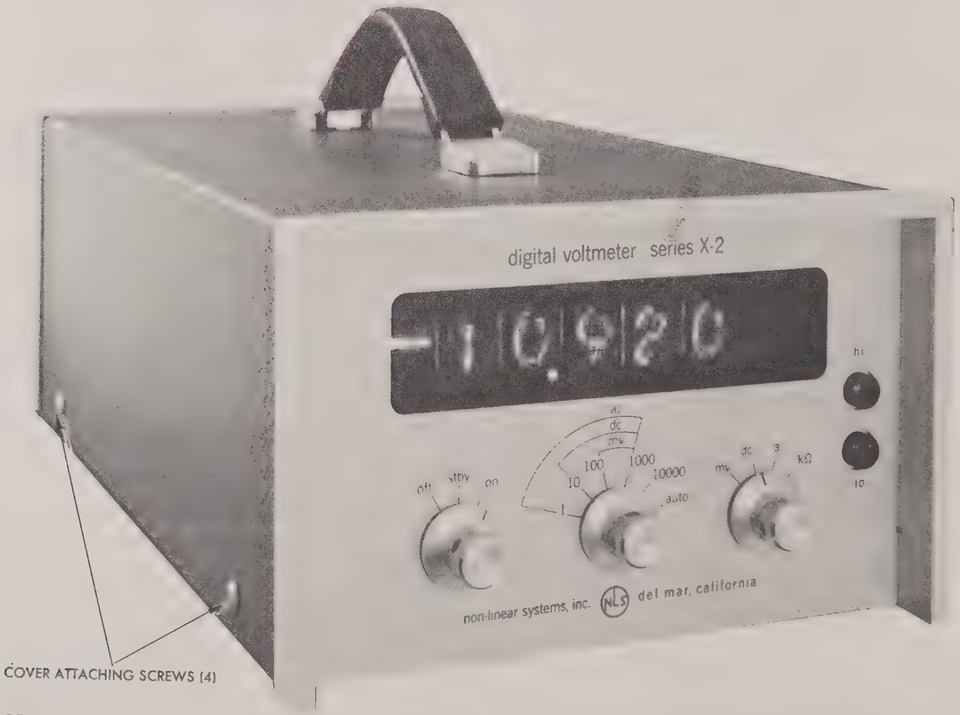
1. Place function switch in the DC position.
2. Place power switch in the ON position.
3. Place range switch in the 10 position.
4. Connect the red and black clips of the DVM input cable together.
5. Rotate the DVM OFFSET potentiometer R1, located on the rear of the instrument, to a position which causes the readout to display ±0.000DC.

10-Volt Range Calibration for a Positive Input Voltage

1. Connect the black lead of the DVM input cable to the negative terminal of the voltage standard described in paragraph 3 under Equipment Required. Connect the read lead to the positive terminal.
2. Apply approximately 9.5 volts.
3. The numerical value displayed in the readout should be equal to the voltage of the voltage standard. If it is not, adjust potentiometer R30 (Figure 3-2) of the Attenuator Assembly, P/N 37-39, until the readout displays the correct value. Note that input impedance of DVM is 10 Megohms.

NOTE

Potentiometers R31 and R38 (Figure 3-2) have been adjusted and sealed at the factory and must not be adjusted in the field. They are temperature coefficient compensators for the ± prime calibration.



COVER ATTACHING SCREWS (4)

3700-6

Figure 3-1. Cover Removal

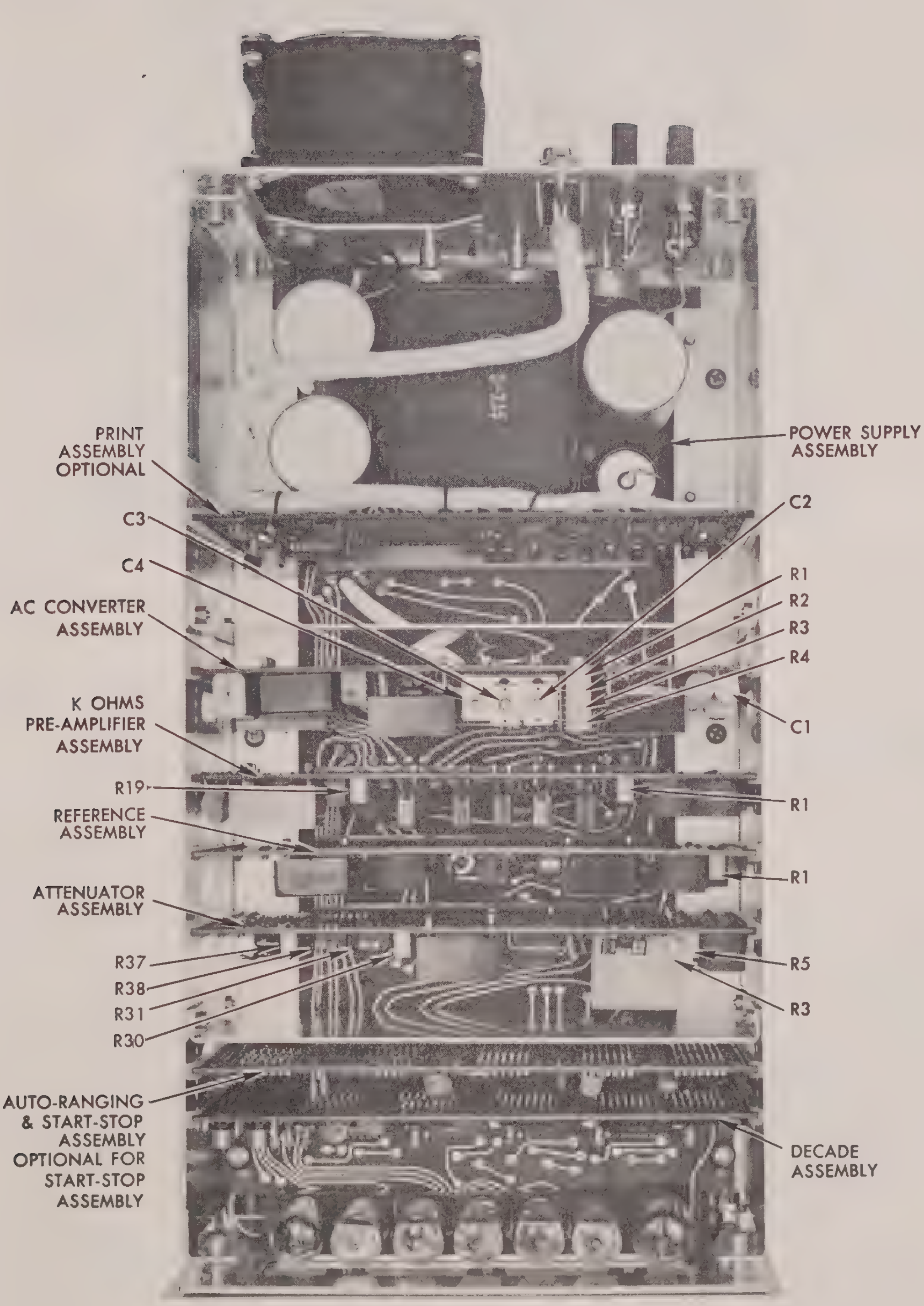

PRINT ASSEMBLY OPTIONAL
POWER SUPPLY ASSEMBLY
C3
C2
C4
R1
R2
AC CONVERTER ASSEMBLY
R3
R4
K OHMS PRE-AMPLIFIER ASSEMBLY
C1
R19
R1
REFERENCE ASSEMBLY
R1
ATTENUATOR ASSEMBLY
R37
R5
R38
R31
R3
R30
AUTO-RANGING & START-STOP ASSEMBLY OPTIONAL FOR START-STOP ASSEMBLY
DECADE ASSEMBLY

Figure 3-2. Location of Major Subassemblies and Adjustment Points

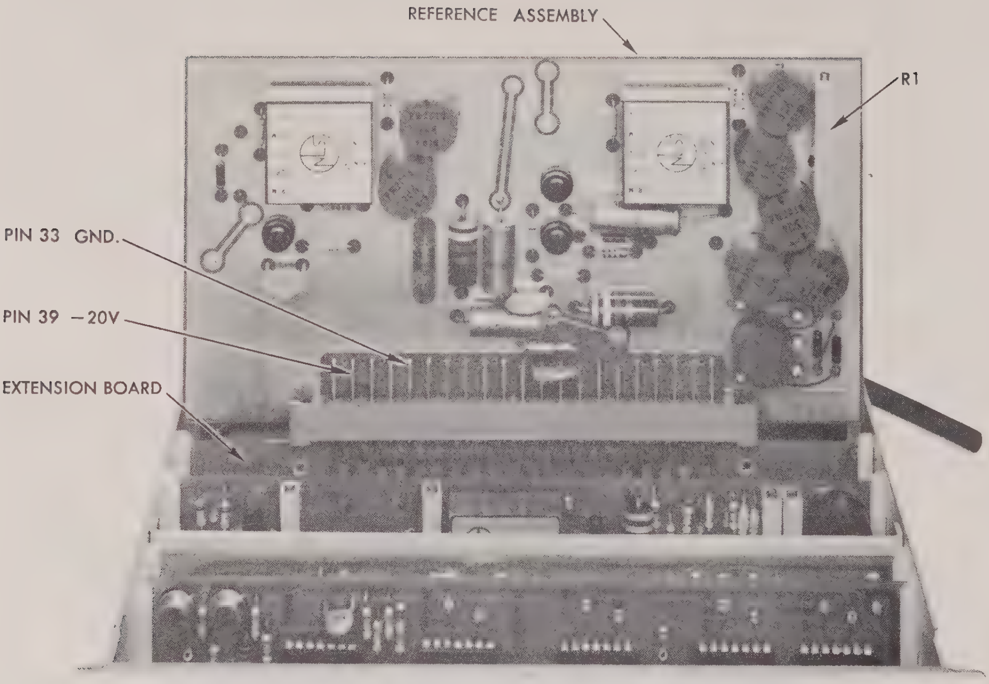


Figure 3-3. Reference Adjustment

10-Volt Range Calibration for a Negative Input Voltage

1. Reverse the connections to the voltage standard.
2. Apply approximately 9.5 volts.
3. The numerical value displayed in the readout should be equal to the voltage of the voltage standard. If it is not, adjust potentiometer R37 (Figure 3-2) of the Attenuator Assembly until the readout displays the correct value.

WARNING

Use extreme caution in performing the following steps as dangerously high voltages will be employed.

100-Volt Range Calibration

1. Place the range switch in 100 position.
2. Connect the black lead of the DVM input cable to the negative terminal of the voltage standard described in paragraph 4 under Equipment Required. Connect the red lead to the positive terminal.
3. Apply approximately 95 volts.
4. The numerical value displayed in the readout should be equal to the voltage of the voltage standard. If it is not, adjust potentiometer R5 (Figure 3-2) of the Attenuator Assembly until the readout displays the correct value.

WARNING

Use extreme caution in performing the following steps as dangerously high voltages will be employed.

1000-Volt Range Calibration

1. Place the range switch in the 1000 position.
2. Connect the black lead of the DVM input cable to the negative terminal of the voltage standard described in paragraph 5 under Equipment Required. Connect the red lead to the positive terminal.
3. Apply approximately 950 volts.
4. The numerical value displayed in the readout should be equal to the voltage standard. If it is not, adjust potentiometer R3 (Figure 3-2) of the Attenuator Assembly until the readout displays the correct value.

AC CONVERTER CALIBRATION

ADDITIONAL EQUIPMENT REQUIRED

1. An Audio Voltage Standard between 1 volt, 200 Hz - 10K Hz and 500 volts, 200 Hz - 10K Hz.

INITIAL PREPARATION

1. Ensure that the instrument is properly calibrated in the DC voltage measurement function and ensure a 30-minute warm-up period.

PROCEDURE

1. Place the function switch in the AC position.
2. Place the range switch in the 1000 position.
3. Place the power switch in the ON position.
4. Connect the red and black clips of the DVM input cable together.
5. Rotate the AC OFFSET potentiometer, R2, located on the rear of the instrument, to a position which causes the readout to display 0.000 AC.

WARNING

Use extreme caution in performing the following steps as dangerously high voltages will be employed.

CAUTION

Do not apply more than 500 VAC or damage to the AC Converter Assembly may result.

6. Connect the red lead of the DVM input cable to the AC HI terminal and the black lead to the AC LO terminal of the Audio Voltage Standard
7. Apply approximately 450.00 volts, 200 Hz and adjust R1 (Figure 3-2) of the AC Converter Assembly until the numerical value displayed in the readout is equal to the voltage applied.
8. Apply approximately 450.00 volts, 10K Hz and adjust C1 (Figure 3-2) of the AC Converter Assembly until the numerical value displayed in the readout is equal to the voltage applied.

WARNING

Use extreme caution in performing the following steps as dangerously high voltage will be employed.

9. Place the range switch in the 100 position. Apply approximately 90.00 volts, 200 Hz and adjust R2 (Figure 3-2) of the AC Converter Assembly until the

numerical value displayed in the readout is equal to the voltage applied.

10. Apply approximately 90.00 volts 10 K Hz and adjust C2 (Figure 3-2) of the AC Converter Assembly until the numerical value displayed in the readout is equal to the voltage applied.

11. Place the range switch in the 10 position. Apply approximately 9.000 volts, 200 Hz and adjust R3 (Figure 3-2) of the AC Converter Assembly until the numerical value displayed in the readout is equal to the voltage applied.

12. Apply approximately 9.000 volts, 10K Hz and adjust C3 of the AC Converter Assembly until the numerical value displayed in the readout is equal to the voltage applied.

13. Apply approximately 0.9000 volts, 200 Hz and adjust R4 (Figure 3-2) of the AC Converter Assembly until the numerical value displayed in the readout is equal to the voltage applied.

14. Apply approximately 0.9000 volts, 10K Hz and adjust C4 (Figure 3-2) of the AC Converter Assembly until the numerical value displayed in the readout is equal to the voltage applied.

OHMS CONVERTER AND PRE-AMPLIFIER CALIBRATION

ADDITIONAL EQUIPMENT REQUIRED

1. An ohms standard accurate to 0.01%.

2. A voltage standard between 90.00 millivolts and 1199.98 millivolts.

INITIAL PREPARATION

1. Ensure that the instrument is properly calibrated in the DC voltage measurement function and ensure a 30-minute warm-up period.

PROCEDURE

1. Place the power switch in the ON position.

2. Place the range switch in the 100 position.

3. Place the function switch in the MV position.

4. Connect the red and black clips of the DVM input cable together.

5. Rotate the KΩ/MV OFFSET R3 potentiometer, located at the rear of the instrument, to a position which causes the readout to display 00.00 MV.

6. Connect the black lead of the DVM input cable to the negative terminal of the voltage standard described in paragraph 2 under Additional Equipment Required. Connect the red lead to the positive terminal.

7. Apply approximately 95.00 millivolts and adjust R19 of the Ohms Converter/Pre-Amplifier Assembly (Figure 3-2) until the numerical value displayed in the readout is equal to the voltage of the voltage standard.

8. Place the range switch in the 1000 position. (S/N's X-2.189 & subsequent).

9. Apply approximately 950.00 millivolts and adjust R37 (located to the left of R19) of the ohms converter/pre-amplifier assembly until the numerical value displayed in the readout is equal to the voltage of the voltage standard.

10. Place the range switch in the 10000 posi-position.

11. Place the function switch in the KΩ position.

12. Connect the red and black clips of the DVM input cable together.

13. Rotate the KΩ/MV OFFSET R3 potentiometer, located on the rear of the instrument, to a position which causes the readout to display 0000 KΩ.

14. Connect the two leads of the DVM input cable to the output terminals of the ohms standard.

15. Apply approximately 9000 KΩ and adjust R1 (Figure 3-2) of the ohms converter and pre-amplifier assembly until the numerical value displayed in the readout is equal to the ohmic value applied.

PRECISION PRE-AMPLIFIER CALIBRATION

INITIAL PREPARATION

1. Ensure that the instrument is properly calibrated in the DC voltage measurement function and ensure a 30-minute warm-up period.

PROCEDURE

1. Place the power switch in the ON position.

2. Place the range switch in the 100 position.

3. Place the function switch in the MV position.

4. Connect the red and black clips of the DVM input cable together.

5. Rotate the KΩ/MV OFFSET R3 potentiometer, located on the rear of the instrument, to a position which causes the readout to display 00.00 MV.

6. Connect the black lead of the DVM input cable to the negative terminal of the voltage standard described in paragraph 2 under Additional Equipment Required. Connect the red lead to the positive terminal.

7. Apply approximately 95.00 millivolts and adjust R1 of the Ohms Converter/Pre-amplifier assembly (Figure 3-4) until the numerical value displayed in the readout is equal to the voltage of the voltage standard.

8. Place the range switch in the 1000 position.

9. Apply approximately 950.00 millivolts and adjust R2 of the preamplifier assembly until the numerical value displayed in the readout is equal to the voltage of the voltage standard.

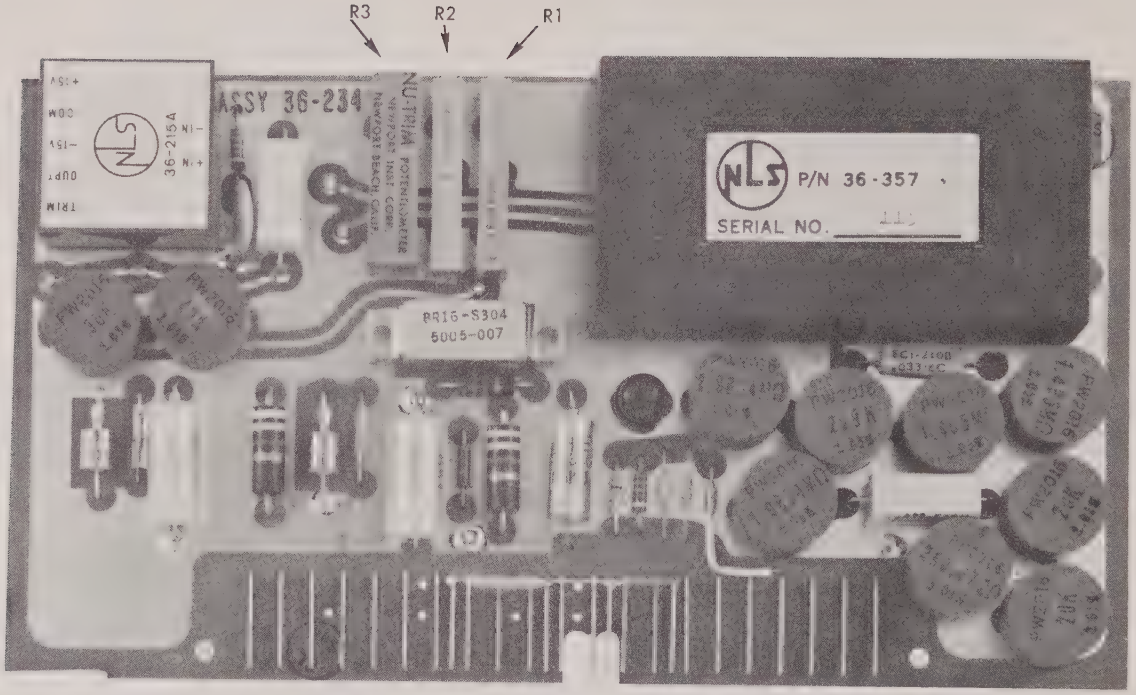

R3
R2
R1
ASSY 36-234
NU-TRIM POTENTIOMETER
NEWPORT INST. CORP.
NEWPORT BEACH CALIF.
+15V
COM
-15V
OUPT
TRIM
36-215A
NLS
NI-
NI+
NLS P/N 36-357
SERIAL NO.
8R16-S304
5005-007

Figure 3-4. Precision Pre-amplifier Assembly Adjustment Points

CHAPTER IV

MAINTENANCE

In the Series X-2 Digital Voltmeter, virtually all circuit components are assembled on plug-in modules. Thus maintenance problems are simplified to the point where the instrument can be kept operating without the need for highly trained maintenance personnel. Because of this plug-in design, downtime is held to a minimum; the unit can be kept operating in locations from which it would be impractical or inconvenient to send the instrument to a repair facility or to the manufacturer. Only a very few minutes are needed to replace all the plug-in boards. By using trial-and-error techniques the instrument can be rapidly returned to service, and the defective module repaired at a later date.

For a general understanding of the principles of operation of the Series X-2 DVM, refer to Figures 4-1 through 4-15. For a more detailed analysis, refer to the schematic and wiring diagrams at the end of this manual.

In order to pursue the plug-in philosophy to the fullest, spare modules as listed in Section V, Recommended Spare Parts List, should be kept in stock.

If it is desired to measure voltages and check waveforms on a particular plug-in module, a 41-pin extension board will be required to raise the board so that pin contacts become accessible. These boards, NLS part number 1009-41, may be ordered from any NLS representative or from the NLS Main Office in Del Mar, California.

TROUBLESHOOTING

For troubleshooting information, refer to Table 4-1.

DIGITAL READOUT REPLACEMENT

The readout tubes providing the digital, polarity and function displays have exceedingly long-life expectancy and rarely require replacement. However, to replace a readout tube in the event of failure, perform the following steps:

1. Remove the cover from the instrument by removing the four screws (two on each side) attaching the cover to the chassis.
2. Remove the decade assembly (front board) from the instrument.
3. Firmly grasp the decade assembly with one hand and the malfunctioning tube with the other.
4. With a rocking motion, carefully pull the tube from its socket.
5. Install new tube, using care to properly align pins into tube socket, and replace decade board and cover in reverse order of removal.

FAN LUBRICATION

Under normal operating conditions, the ventilating fan (S/N's X-2.157 thru X-2.462 and those earlier S/N's so modified) should be lubricated every two or three months.

To lubricate the fan, remove the blue slotted plug from rear of fan assembly and apply two or three drops of Rotron M-21 lubricant.

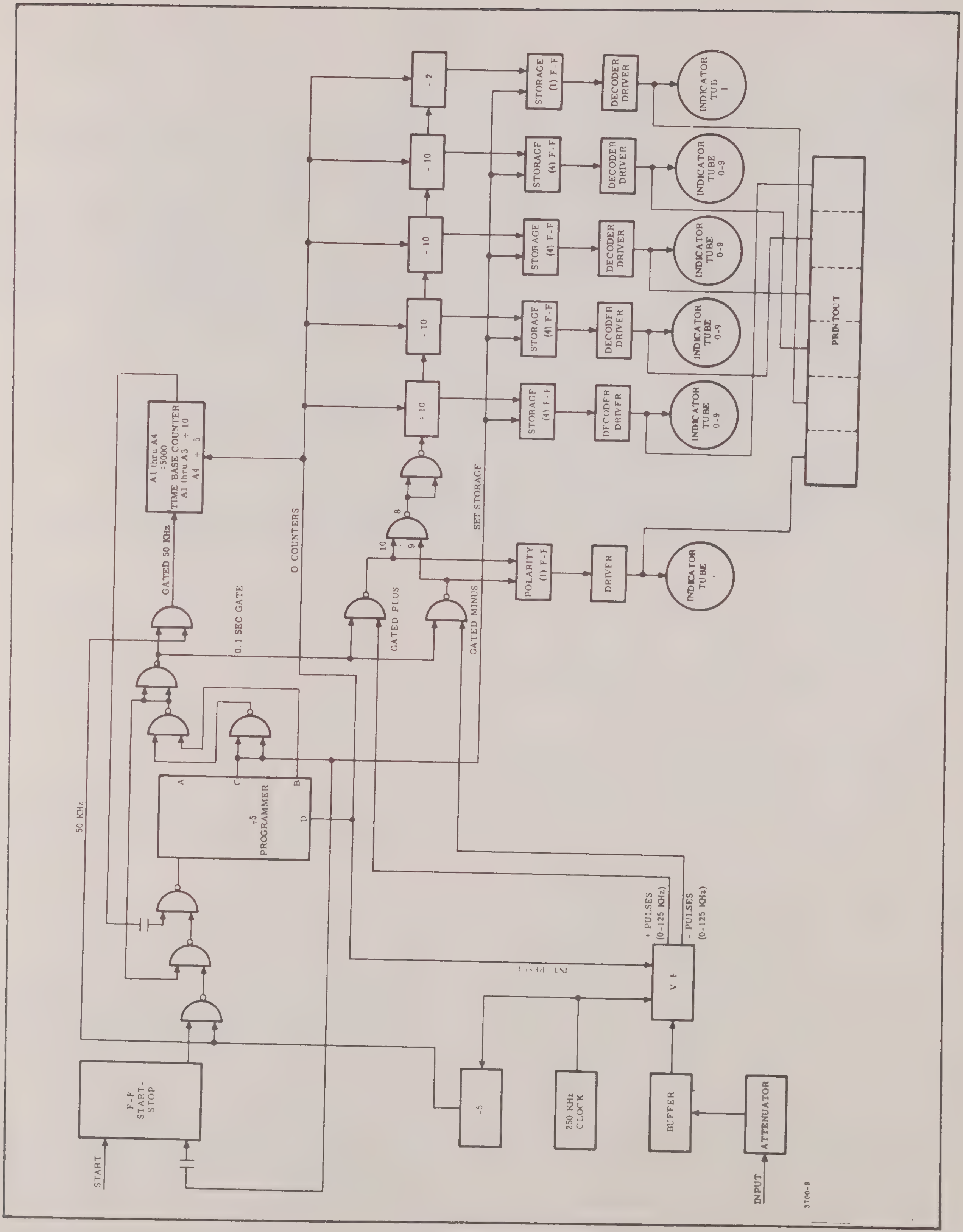
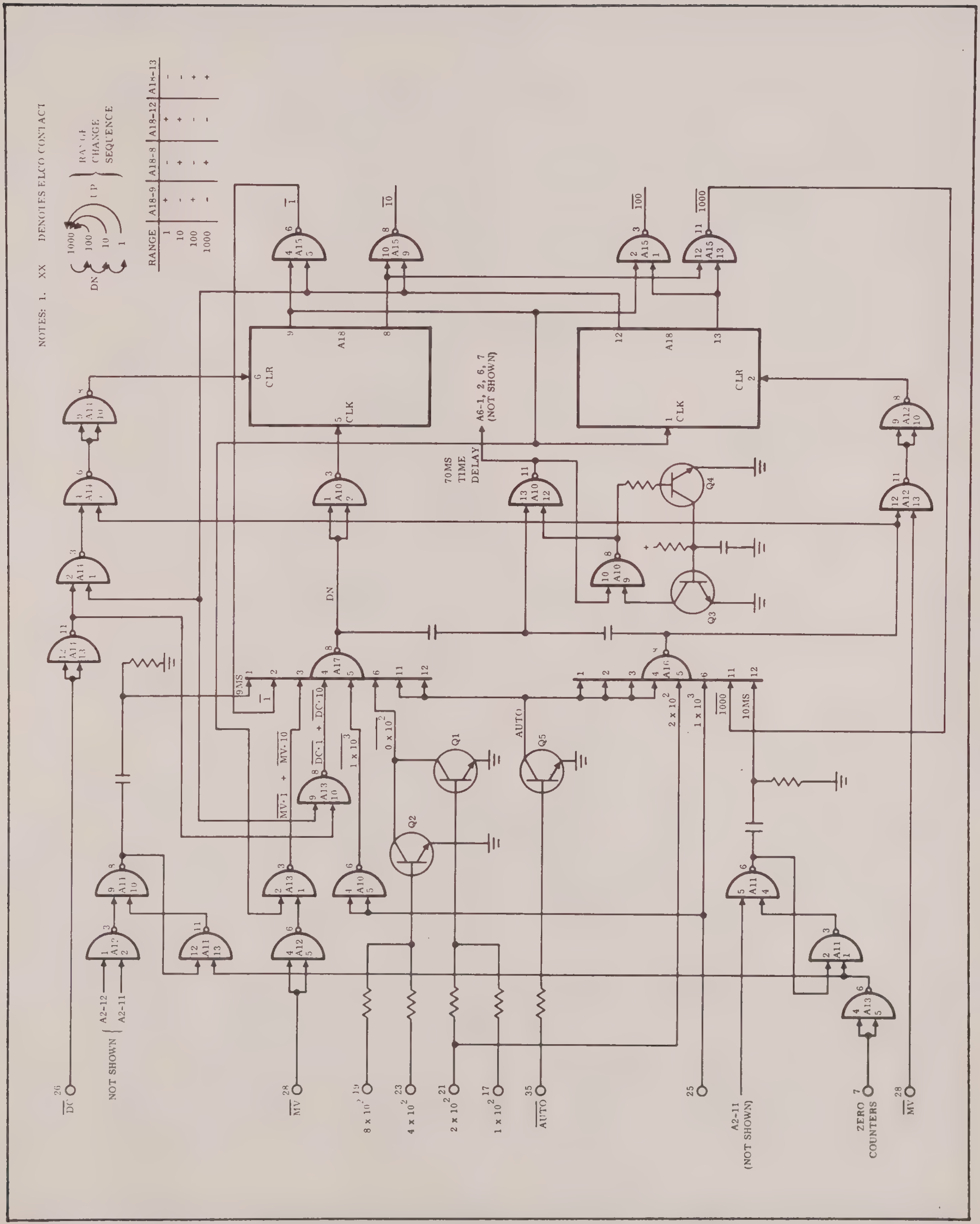

START
F-F START-STOP
50 KHz
÷5 PROGRAMMER
A
B
C
D
0.1 SEC GATE
GATED 50 KHz
A1 thru A4 ÷5000
TIME BASE COUNTER
A1 thru A3 ÷ 10
A4 ÷ 5
O COUNTERS
GATED PLUS
GATED MINUS
SET STORAGE
10
8
9
÷ 10
÷ 2
STORAGE (1) F-F
STORAGE (4) F-F
POLARITY (1) F-F
DECODER DRIVER
DRIVER
INDICATOR TUBE 1
INDICATOR TUBE 0-9
INDICATOR TUBE
PRINTOUT
+ PULSES (0-125 KHz)
- PULSES (0-125 KHz)
V F
÷5
250 KHz CLOCK
BUFFER
ATTENUATOR
INPUT
3700-9

Figure 4-1. Block Diagram Series X-2 DVM



NOTES: 1. XX DENOTES ELCO CONTACT

DN
UP
1000
100
10
1
RANGE CHANGE SEQUENCE

RANGE	A18-9	A18-8	A18-12	A18-13
1	+	-	+	-
10	-	+	+	-
100	+	-	-	+
1000	-	+	-	+

A18
CLR
CLK
A15
A17
A16
A14
A13
A12
A11
A10
Q1
Q2
Q3
Q4
Q5
DN
AUTO
9MS
10MS
70MS TIME DELAY
A6-1, 2, 6, 7 (NOT SHOWN)
MV·1 + MV·10
DC·1 + DC·10
1 x 10^3
0 x 10^2
2 x 10^2
1 x 10^3
1000
26 DC
NOT SHOWN A2-12 A2-11
28 MV
19 8 x 10^2
23 4 x 10^2
21 2 x 10^2
17 1 x 10^2
35 AUTO
25
A2-11 (NOT SHOWN)
7 ZERO COUNTERS
28 MV
1
10
100
1000

Figure 4-2. Simplified Diagram, Auto-ranging

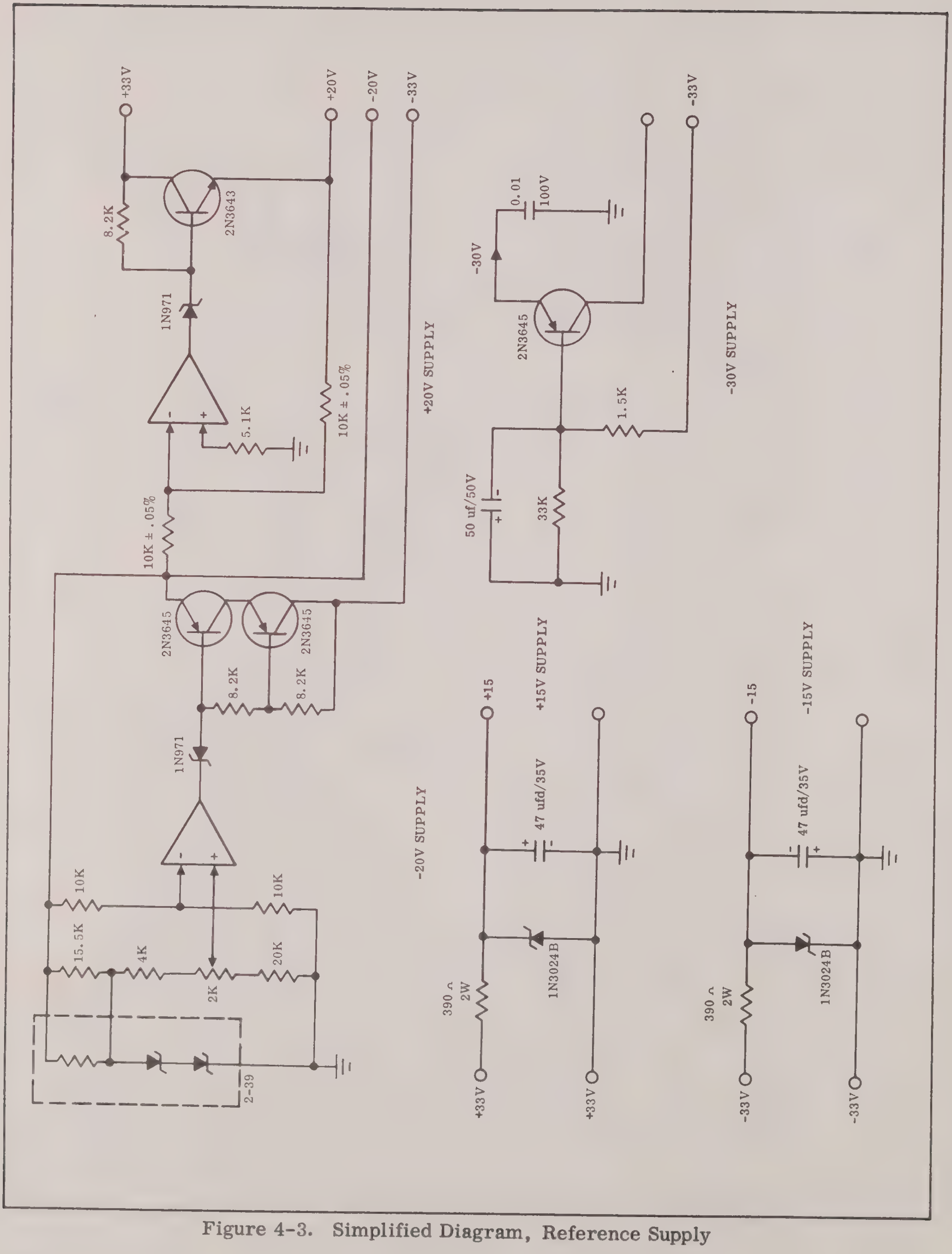

+33V
+20V
-20V
-33V
8.2K
2N3643
1N971
5.1K
10K ± .05%
+20V SUPPLY
10K ± .05%
2N3645
2N3645
8.2K
8.2K
1N971
10K
10K
15.5K
4K
2K
20K
2-39
-20V SUPPLY
-30V
0.01
100V
2N3645
1.5K
50 uf/50V
33K
-33V
-30V SUPPLY
+15
+15V SUPPLY
47 ufd/35V
1N3024B
390 Ω
2W
+33V
+33V
-15
-15V SUPPLY
47 ufd/35V
1N3024B
390 Ω
2W
-33V
-33V

Figure 4-3. Simplified Diagram, Reference Supply

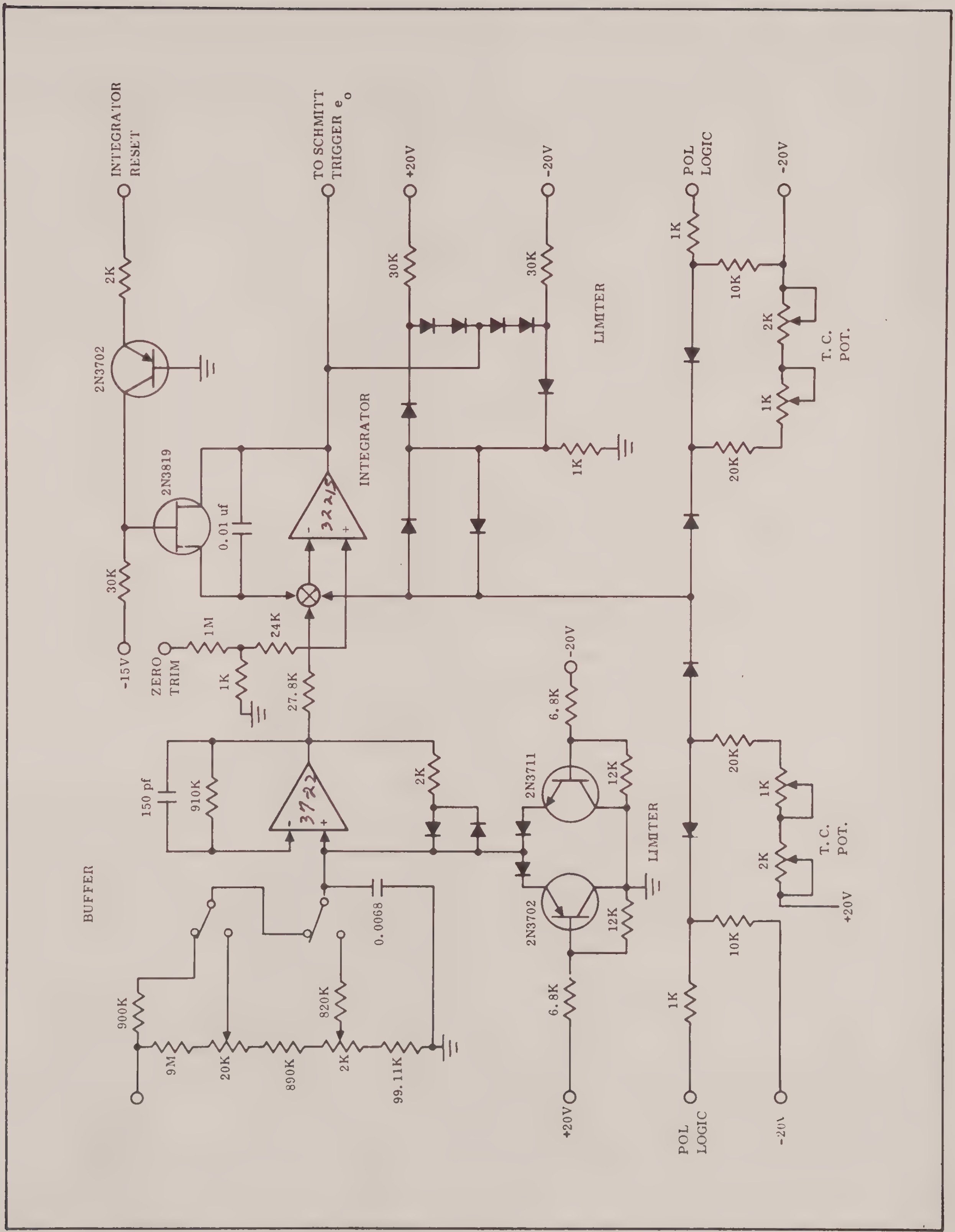
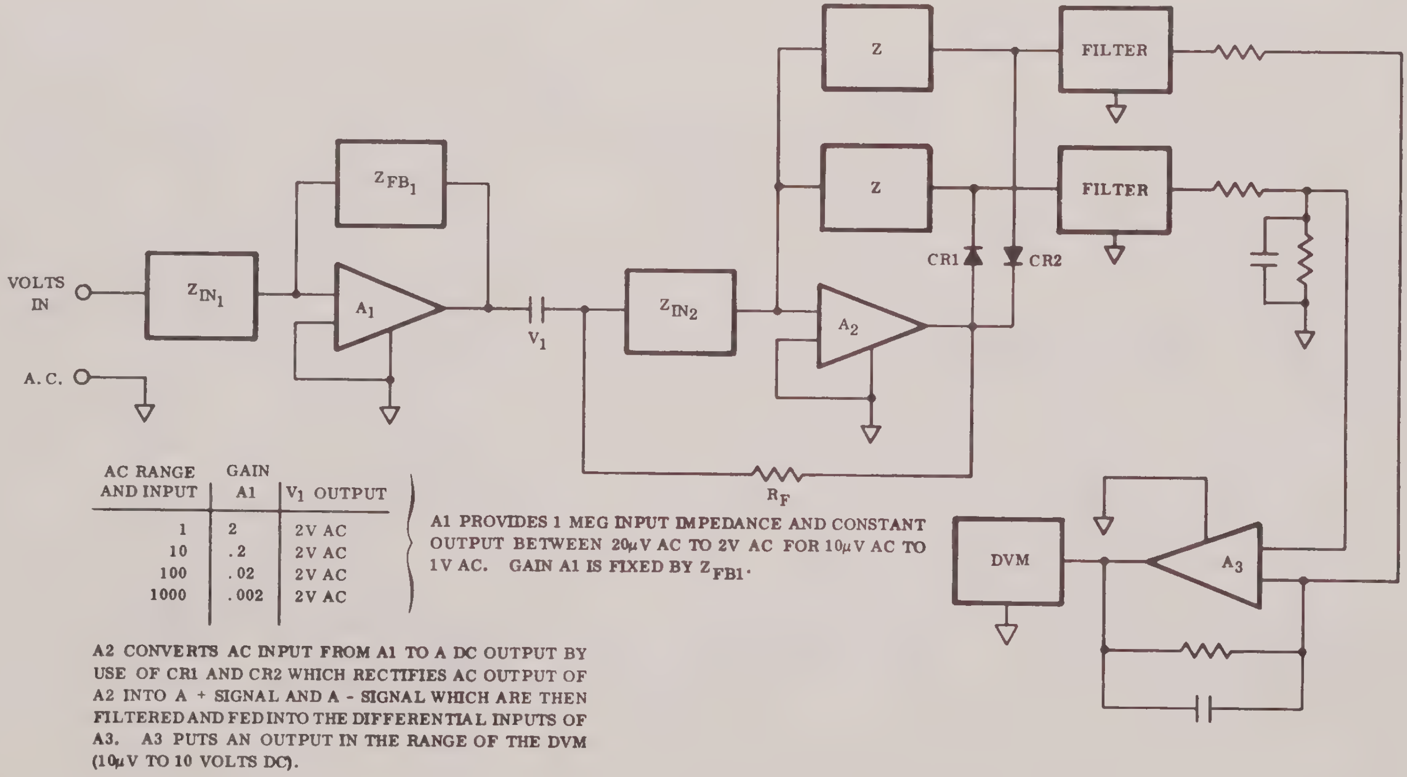

INTEGRATOR RESET
2K
2N3702
2N3819
30K
-15V
TO SCHMITT TRIGGER e_o
0.01 uf
3221S
INTEGRATOR
+20V
30K
-20V
30K
LIMITER
1K
POL LOGIC
1K
10K
-20V
2K
T.C. POT.
1K
20K
ZERO TRIM
1M
24K
1K
27.8K
BUFFER
150 pf
910K
3722
2K
-20V
6.8K
2N3711
12K
LIMITER
2N3702
12K
6.8K
+20V
0.0068
900K
9M
20K
890K
820K
2K
99.11K
20K
1K
T.C. POT.
2K
+20V
10K
1K
POL LOGIC
-20V

Figure 4-4. Simplified Diagram, Series X-2 Input - Integrator with Resetter Circuitry and Temperature Compensation Potentiometers


VOLTS IN
A.C.
Z_{IN_1}
Z_{FB_1}
A_1
V_1
Z_{IN_2}
A_2
R_F
CR1
CR2
Z
Z
FILTER
FILTER
A_3
DVM

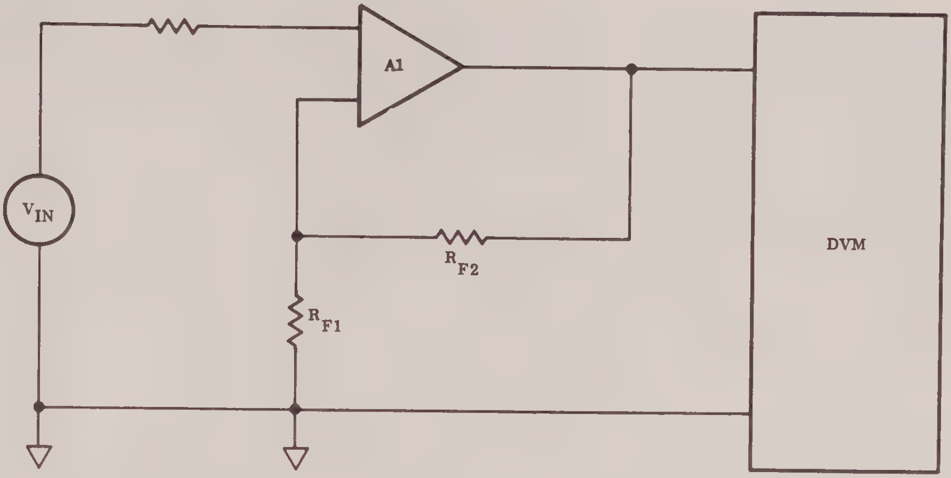
AC RANGE AND INPUT	GAIN A1	V_1 OUTPUT
1	2	2V AC
10	.2	2V AC
100	.02	2V AC
1000	.002	2V AC

A1 PROVIDES 1 MEG INPUT IMPEDANCE AND CONSTANT OUTPUT BETWEEN 20μV AC TO 2V AC FOR 10μV AC TO 1V AC. GAIN A1 IS FIXED BY Z_{FB1}.

A2 CONVERTS AC INPUT FROM A1 TO A DC OUTPUT BY USE OF CR1 AND CR2 WHICH RECTIFIES AC OUTPUT OF A2 INTO A + SIGNAL AND A - SIGNAL WHICH ARE THEN FILTERED AND FED INTO THE DIFFERENTIAL INPUTS OF A3. A3 PUTS AN OUTPUT IN THE RANGE OF THE DVM (10μV TO 10 VOLTS DC).

3600-26

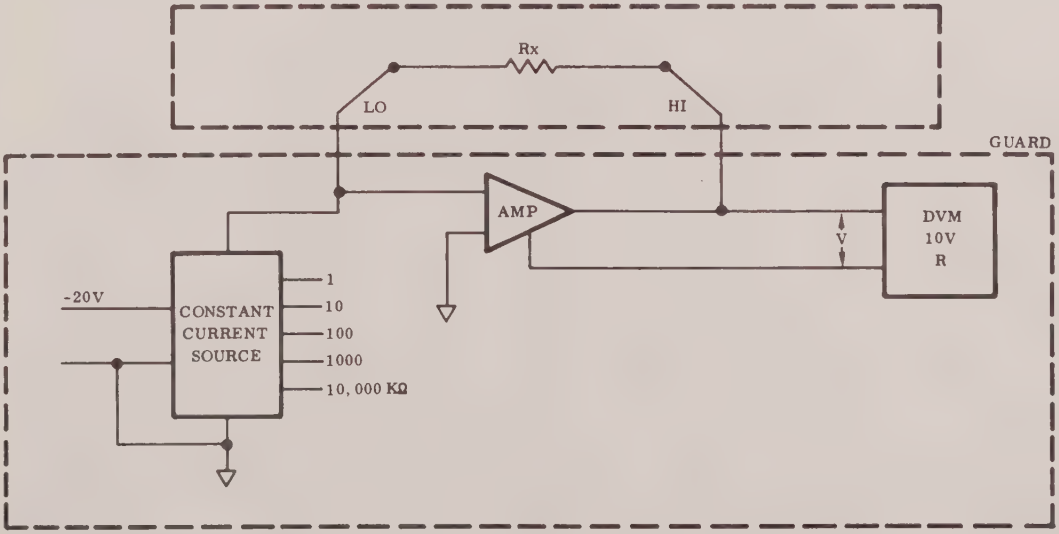
Figure 4-5. Simplified Diagram AC Converter


A1
DVM
V_{IN}
R_{F2}
R_{F1}

$$\text{GAIN} = \frac{R_{F1} \times R_{F2}}{R_{F1}}$$

3700-3

Figure 4-6. Simplified Diagram Pre-amplifier


Rx
LO
HI
GUARD
AMP
V
DVM
10V
R
-20V
CONSTANT
CURRENT
SOURCE
1
10
100
1000
10, 000 KΩ

$V = I\ R_X$ (FULL SCALE) = 10 VOLTS

R_X	I
1K	10MA
10K	1MA
100K	100μA
1000K	10μA
10, 000K	1μA

3700-2

Figure 4-7. Simplified Diagram Ohms Converter

TRUTH TABLES

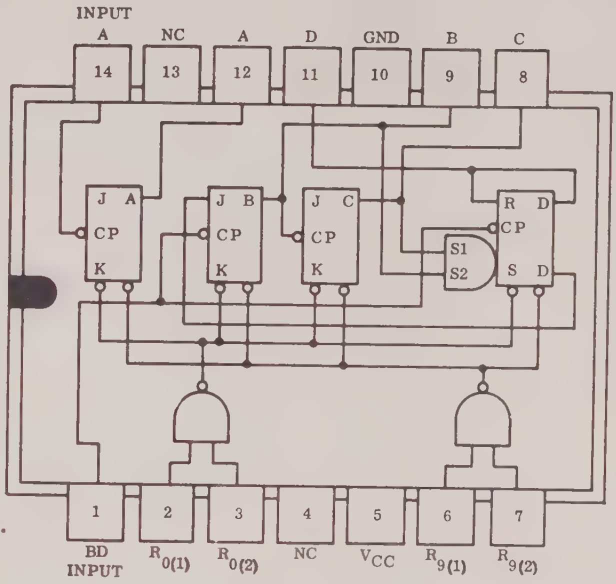
BCD COUNT SEQUENCE
(SEE NOTE 1)

COUNT	OUTPUT D	C	B	A
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1

RESET/COUNT (SEE NOTE 2)

RESET INPUTS $R_{0(1)}$	$R_{0(2)}$	$R_{9(1)}$	$R_{9(2)}$	OUTPUT D C B A
1	1	0	X	0000
1	1	X	0	0000
X	0	1	1	1001
0	X	1	1	1001
1	1	1	1	1001
X	0	X	0	COUNT
0	X	0	X	COUNT
0	X	X	0	COUNT
X	0	0	X	COUNT

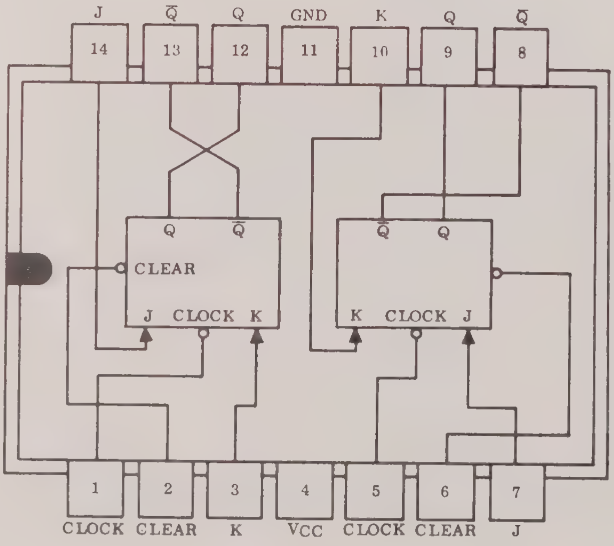
NOTES:
1. OUTPUT A CONNECTED TO INPUT BD FOR BCD COUNT.
2. X INDICATES THAT EITHER A LOGICAL 1 OR A LOGICAL 0 MAY BE PRESENT.


INPUT A
NC
A
D
GND
B
C
14
13
12
11
10
9
8
J A
CP
K
J B
CP
K
J C
CP
K
R D
CP
S D
S1
S2
1
2
3
4
5
6
7
BD INPUT
$R_{0(1)}$
$R_{0(2)}$
NC
V_{CC}
$R_{9(1)}$
$R_{9(2)}$

POSITIVE LOGIC
SEE TRUTH TABLES
NC—NO INTERNAL CONNECTION

3700-10

Figure 4-8. Type SN7490N Decade Counter


J
Q̄
Q
GND
K
Q
Q̄
14
13
12
11
10
9
8
Q
Q̄
CLEAR
J CLOCK K
Q̄
Q
K CLOCK J
1
2
3
4
5
6
7
CLOCK
CLEAR
K
VCC
CLOCK
CLEAR
J

POSITIVE LOGIC
LOW INPUT TO CLEAR SETS Q TO LOGICAL 0
REGARDLESS OF CLOCK STATE.

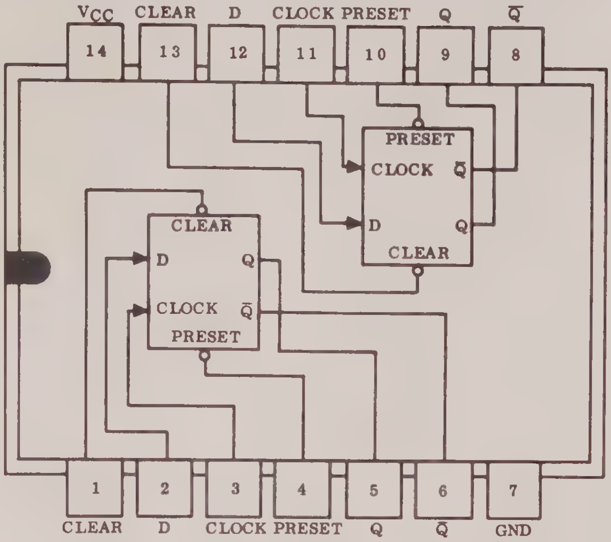
3700-11

TRUTH TABLE (EACH FLIP-FLOP)

t_n J	t_n K	$t_n + 1$ Q
0	0	Q_n
0	1	0
1	0	1
1	1	$\bar{Q}_n$

NOTES:
1. t_n = BIT TIME BEFORE CLOCK PULSE.
2. $t_n + 1$ = BIT TIME AFTER CLOCK PULSE.

Figure 4-9. Type SN7473N Dual J-K Master-Slave Flip-Flop


VCC
CLEAR
D
CLOCK
PRESET
Q
Q̄
14
13
12
11
10
9
8
PRESET
CLOCK
Q̄
D
Q
CLEAR
CLEAR
D
Q
CLOCK
Q̄
PRESET
1
2
3
4
5
6
7
CLEAR
D
CLOCK
PRESET
Q
Q̄
GND

TRUTH TABLE (EACH FLIP-FLOP)

t_n	$t_n + 1$	
INPUT D	OUTPUT Q	OUTPUT $\bar{Q}$
0	0	1
1	1	0

NOTES:
1. t_n = BIT TIME BEFORE CLOCK PULSE.
2. $t_n + 1$ = BIT TIME AFTER CLOCK PULSE.

POSITIVE LOGIC

a. LOW INPUT TO CLEAR SETS Q TO LOGICAL 0.
b. LOW INPUT TO PRESET SETS Q TO LOGICAL 1.
c. CLEAR OR PRESET INPUTS DOMINATE REGARDLESS OF CLOCK AND D INPUTS.

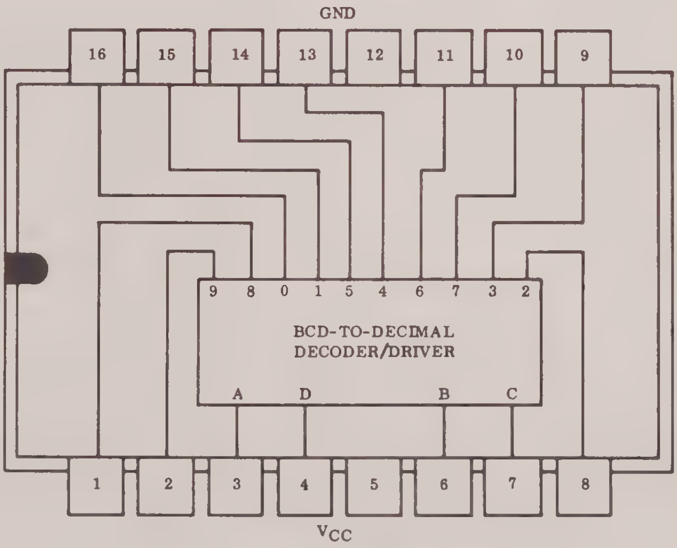
3700-12

Figure 4-10. Type SN7474N Dual D-Type Edge-Triggered Flip-Flop

TRUTH TABLE

INPUT				OUTPUT ON ‡
D	C	B	A	
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	8
1	0	0	1	9

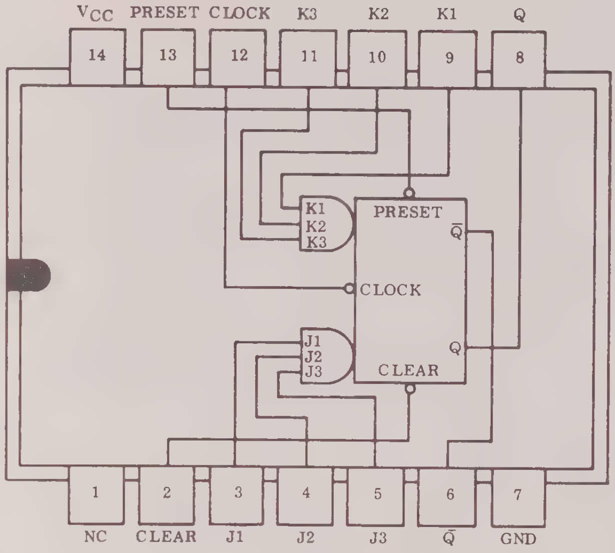
‡ ALL OTHER OUTPUTS ARE OFF.


GND
16
15
14
13
12
11
10
9
9
8
0
1
5
4
6
7
3
2
BCD-TO-DECIMAL DECODER/DRIVER
A
D
B
C
1
2
3
4
5
6
7
8
VCC

3700-13

POSITIVE LOGIC
SEE TRUTH TABLE

Figure 4-11. Type SNX7441N BCD-to-Decimal Decoder/Driver


VCC
PRESET
CLOCK
K3
K2
K1
Q
14
13
12
11
10
9
8
K1
K2
K3
PRESET
$\overline{Q}$
CLOCK
J1
J2
J3
Q
CLEAR
1
2
3
4
5
6
7
NC
CLEAR
J1
J2
J3
$\overline{Q}$
GND

TRUTH TABLE		
t_n		$t_n + 1$
J	K	Q
0	0	Q_n
0	1	0
1	0	1
1	1	$\overline{Q}_n$

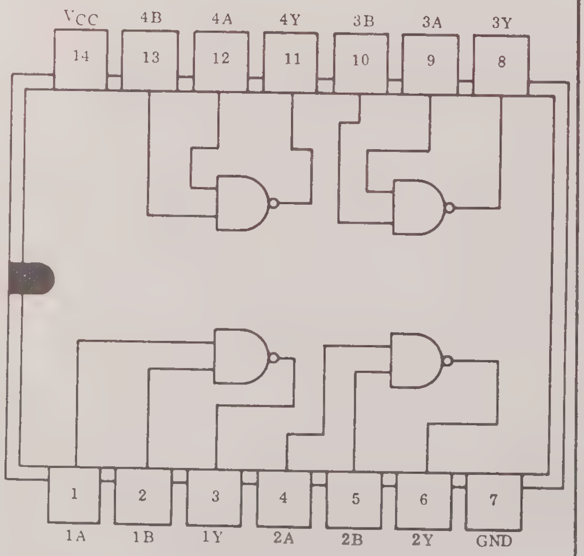
NOTES: 1. $J = J1 \cdot J2 \cdot J3$
2. $K = K1 \cdot K2 \cdot K3$
3. t_n = BIT TIME BEFORE CLOCK PULSE.
4. $t_n + 1$ = BIT TIME AFTER CLOCK PULSE.

POSITIVE LOGIC
LOW INPUT TO PRESET SETS Q TO LOGICAL 1
LOW INPUT TO CLEAR SETS Q TO LOGICAL 0

NC–NO INTERNAL CONNECTION.

3700-14

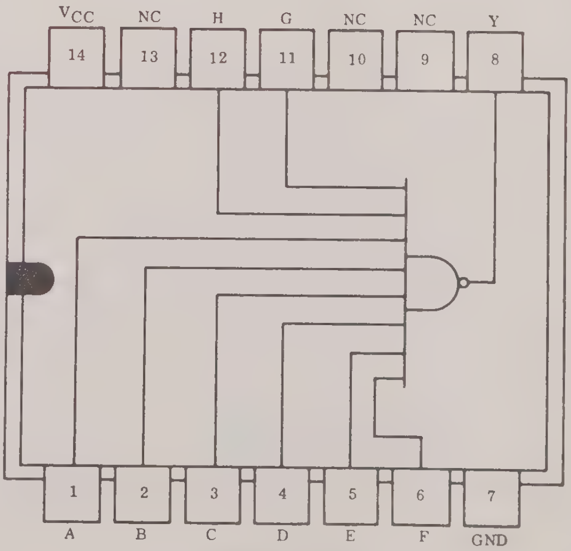
Figure 4-12. Type SN 7472N JK Master-Slave Flip-Flop


VCC
4B
4A
4Y
3B
3A
3Y
14
13
12
11
10
9
8
1
2
3
4
5
6
7
1A
1B
1Y
2A
2B
2Y
GND

POSITIVE LOGIC
$Y = \overline{AB}$

3700-15

Figure 4-13. Type SN7400N Quadruple 2-Input Positive Nand Gate


VCC
NC
H
G
NC
NC
Y
14
13
12
11
10
9
8
1
2
3
4
5
6
7
A
B
C
D
E
F
GND

POSITIVE LOGIC
$Y = \overline{ABCDEFGH}$

3700-16

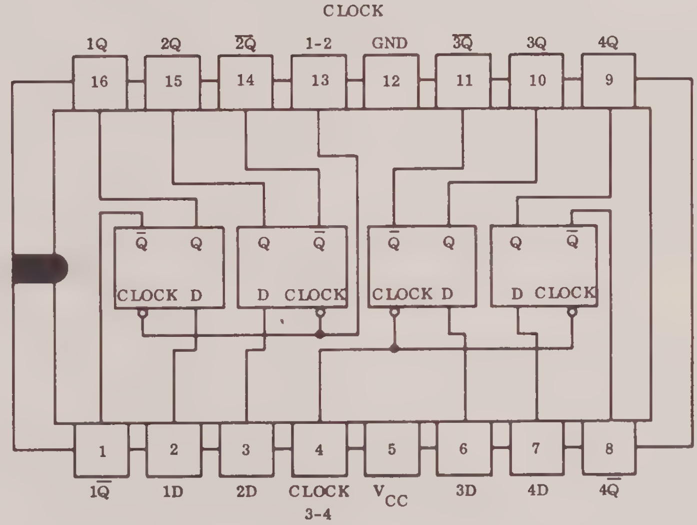
NC–NO INTERNAL CONNECTION

Figure 4-14. Type SN7430N 8-Input Positive Nand Gate

TRUTH TABLE
(EACH LATCH)

t_n	$t_n + 1$	
D	Q	$\overline{Q}$
1	1	0
0	0	1

NOTES:
1. t_n = BIT TIME BEFORE CLOCK PULSE.
2. $t_n + 1$ = BIT TIME AFTER CLOCK PULSE


CLOCK
1Q
2Q
$\overline{2Q}$
1-2
GND
$\overline{3Q}$
3Q
4Q
16
15
14
13
12
11
10
9
$\overline{Q}$
Q
CLOCK
D
Q
$\overline{Q}$
D
CLOCK
$\overline{Q}$
Q
CLOCK
D
Q
$\overline{Q}$
D
CLOCK
1
2
3
4
5
6
7
8
$\overline{1Q}$
1D
2D
CLOCK
3-4
V_{CC}
3D
4D
$\overline{4Q}$

3700-17

Figure 4-15. Type SN7475N Quadruple Bistable Latch

TABLE II. Troubleshooting

SYMPTOM	PROBABLE CAUSE	CORRECTION
No readout when the POWER switch is positioned to ON	No line-voltage	Check line-voltage Check power cable
	230-volt instrument plugged into 115-volt power outlet	Plug into 230-volt power outlet
	Open fuse F1 in power supply	Replace fuse
	200V power supply defective	Repair 200V power supply C4, R4, R5, R15, CR9, CR12, and Q6
No response to input in KΩ function	Open fuse F1 in Kμ/MV Converter Assembly	Replace fuse
Blank indicator in readout	Defective indicator tube	Replace indicator tube
	Defective indicator tube driver	Replace A11, A12, A13, or A14
Samples and measures when POWER switch is in REMOTE position	POWER switch defective	Replace switch S1
Does not sample continuously when POWER switch is in ON position	POWER switch defective	Replace switch S1
	Defective Attenuator Assembly	Repair or replace
	Defective Reference Assembly	Repair or replace
	Defective Start/Stop and Auto-Range Assembly	Repair or replace
Errors in one polarity but not in other	10V range not properly calibrated	Check calibration and adjust as necessary
Samples but does not change readout	Defective Decade Assembly	Repair or replace
Function does not control the instrument properly	Function switch defective	Replace switch S3
Range switch does not control instrument properly, or incorrect decimal point positioning	Defective range switch	Replace switch S2
	Defective Start/Stop and Auto-Range Assembly	Repair or replace
All indicators on simultaneously (blur)	+5V power supply defective	Repair +5V power supply
Unit does not function in AC mode.	Defective function switch	Replace switch S3
	Defective AC/DC Converter Assembly	Repair or replace

TABLE II. Troubleshooting (Con't)

SYMPTOM	PROBABLE CAUSE	CORRECTION
Readings erratic	Defective input cable	Replace input cable
	Defective Reference Assembly	Repair or replace
	Defective Attenuator Assembly	Repair or replace
Some or all decades go to nines	Defective Decade Assembly	Repair or replace
Improper polarity	Defective Decade Assembly	Repair or replace
	Defective Start/Stop and Auto-Range Assembly	Repair or replace
Improper range changing	Defective Start/Stop and Auto-Range Assembly	Replace
+ or - offset in DC	Zero not properly adjusted	Adjust zero
	10V range not properly calibrated	Check calibration and adjust as necessary
Errors in one range but not in others	Range in question not properly calibrated	Check calibration and adjust as necessary
	Defective range resistor on Attenuator Assembly	Replace range resistor
	Defective range relay on Attenuator Assembly	Replace range relay
Offset in low range but not in others	Group loop on input	Check input hookup and eliminate ground loop
Drift	Defective Reference Assembly	Repair or replace
	Defective Attenuator Assembly	Repair or replace
	Defective Start/Stop and Auto-Range Assembly	Repair or replace

CHAPTER V

RECOMMENDED SPARE PARTS LIST

Part No.	Description	Qty.
37-30	Decade Assembly (S/N's X-2 . 1 thru X-2. 301	1
37-36	Reference Assembly (S/N's X-2 . 1 thru X-2. 462)	1
37-39	Attenuator Assembly (S/N's X-2 . 1 thru X-2, 462)	1
37-69	Start-Stop Assembly	1
37-160	Decade Assembly (S/N's X-2. 302 & Subsequent)	1
37-272	Reference Assembly (S/N's X-2. 463 & Subsequent)	1
37-275	Attenuator Assembly (S/N's X-2. 463 & Subsequent)	1
37-360	Decade Assembly (Replaces 37-160)	1
SP2A2	Fan Assembly (S/N's X-2. 157 thru X-2. 462 & others so modified)	1
1009-41	Extension Board (Test Equipment)	1
31300. 5	Fuse, 3AGO. 5A Slo-Blo	6
B5440	Readout Indicator Tube (0 thru 9)	1
B5441	Readout Indicator Tube (0 thru 9 & Decimal)	1
B5448	Readout Indicator Tube (Polarity)	1
2963-C-36	Cable Assembly	1
	ACCESSORIES	
54361	Readout Indicator Tube (Function)	1
37-33	Start-Stop & Auto Range Assembly	1
37-42	Ohms Converter & Pre-Amp Assembly (S/N's X-2. 1 thru X-2. 462)	1
37-45	AC Converter Assembly, 10K Hz (S/N's X-2. 1 thru X-2. 462)	1
37-77	AC Converter Assembly, 100 K Hz (S/N's X-2. 1 thru X-2. 462)	1
37-89	Print Board Assembly (S/N's X-2. 1 thru X-2. 462)	1
37-278	Ohms Converter & Pre-Amp Assembly (S/N's X-2. 463 & Subsequent)	1
37-281	AC Converter Assembly 10K Hz (S/N's X-2. 463 & Subsequent)	1
37-315	AC Converter Assembly 100K Hz (S/N's X-2. 463 & Subsequent)	1
37-316	Print Board Assembly (S/N's X-2. 463 & Subsequent)	1

NOTICE

If at any time it should become necessary to return an NLS instrument to the factory, follow the instructions contained in the Appendix of this manual (page A-1) and utilize NLS Form No. 200-50 (Shipping Notice/Packing Slip), located at the rear of the manual.

APPENDIX

SHIPPING INSTRUCTIONS

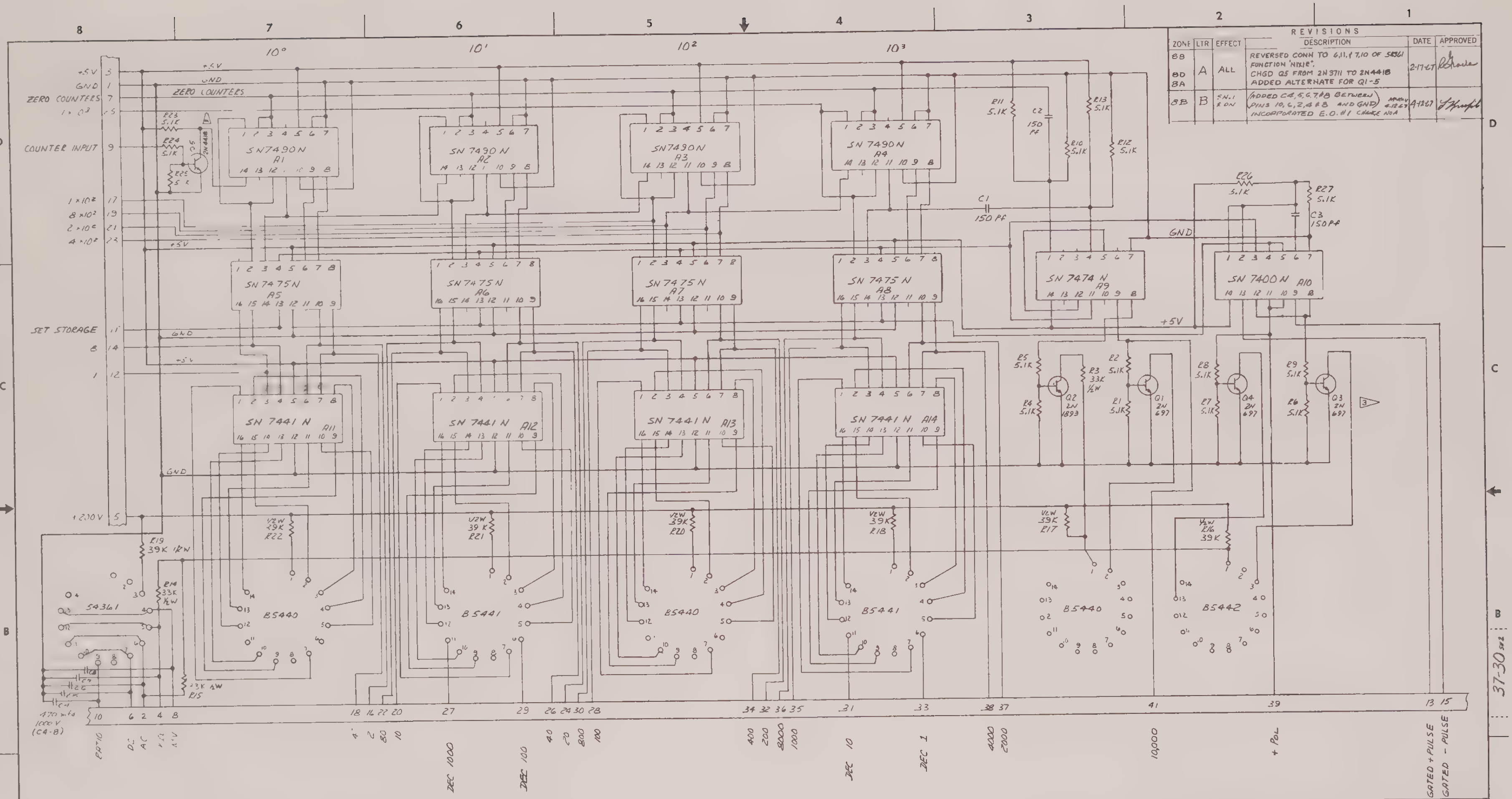
Depending upon location, the choice of carrier will vary. Never ship an instrument to us without having received shipping instructions. If requested, an estimate of charges can be made before work begins.

Be certain to pack the instrument carefully; while an outer and inner box, separated by two or three inches of excelsior is desirable, the instrument can be placed into a single container provided it is so packed that it will not shift about. As with the double box method, use two or three inches of shock-absorbent packing materials. The instrument itself should be first wrapped in heavy paper so as to keep excelsior or other particles from entering the instrument's louvers. If the original shipping container is in good condition, it may be used.

CLAIM FOR DAMAGE IN SHIPMENT

The instrument should be tested as soon as it is received. If it does not operate or is damaged, a claim should be made with the carrier. The claim agent should receive a full report of damage, and this report sent to Non-Linear Systems, Inc. After receiving such a report we will advise you of the disposition of the instrument and arrange for its repair or replacement. Be certain to include model and serial number when corresponding.

ZONE	LTR	EFFECT	DESCRIPTION	DATE	APPROVED
8B 8D 8A	A	ALL	REVERSED CONN TO 6,11,& 7,10 OF 54361 FUNCTION 'NIXIE'. CHGD Q5 FROM 2N3711 TO 2N4418 ADDED ALTERNATE FOR Q1-5	2-17-67	
8B	B	SN-1 & ON	(ADDED C4,5,6,7 & 8 BETWEEN PINS 10,6,2,4 & 8 AND GND) 4.12.67 INCORPORATED E.O. #1 CHANGE NO A	4-12-67	



8
7
6
5
4
3
2
1
D
C
B
A
10°
10'
10²
10³
+5V
GND
ZERO COUNTERS
1 × 0³
COUNTER INPUT
1 ×10²
8 ×10²
2 ×10²
4 ×10²
SET STORAGE
8
1
+200V
R23 5.1K
R24 5.1K
R25 5K
Q5 2N4418
SN7490N A1
SN 7490 N A2
SN7490N A3
SN 7490N A4
SN7475N A5
SN7475N A6
SN 7475N A7
SN 7475 N A8
SN 7474 N A9
SN 7400 N A10
SN 7441 N A11
SN 7441 N A12
SN 7441 N A13
SN 7441 N A14
R11 5.1K
C2 150 PF
R10 5.1K
R13 5.1K
R12 5.1K
C1 150 PF
R26 5.1K
R27 5.1K
C3 150PF
GND
+5V
R5 5.1K
R4 5.1K
Q2 2N 1893
R3 33K ½W
R2 5.1K
R1 5.1K
Q1 2N 697
R8 5.1K
R7 5.1K
Q4 2N 697
R9 5.1K
R6 5.1K
Q3 2N 697
½W 39K R22
½W 39K R21
½W 39K R20
½W 39K R18
½W 39K R17
½W R16 39K
R19 39K ½W
R14 33K ½W
23K ½W R15
54361
B5440
B5441
B5440
B5441
B5440
B5442
470 pfd 1000 V (C4-8)
10 6 2 4 8
18 16 22 20
27
29
26 24 30 28
34 32 36 35
31
33
38 37
41
39
13 15
PR10
DC
AC
4
10
80
10
DEC 1000
DEC 100
40
20
800
100
400
200
8000
1000
DEC 10
DEC 1
4000
2000
10,000
+ POL
GATED + PULSE
GATED - PULSE
37-30 SH2

3 Q1-4 ALTERNATE : A-133 AMPEREX

2 Q5 ALTERNATE · 2N2368 T.I

REFERENCE DESIGNATIONS ARE ABBREVIATED: PREFIX WITH ASSEMBLY DESIGNATION SHOWN ON SHEET 2 OF FINAL ASSEMBLY

NOTES [illegible]

QTY REQD	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF	ITEM NO

PARTS LIST

37-2	37-2	1	1
NEXT ASSY.	FINAL ASSY.	NEXT ASSY	FINAL ASSY
APPLICATION		QTY	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010
FRACTIONS ± 1/32
ANGLES ± 0° 30'

MATERIAL

CONTR. NO
DRAWN 1-10-67
CHECK 2-10-67
APPR 2-10-67
RELEASE DATE 2-15-67

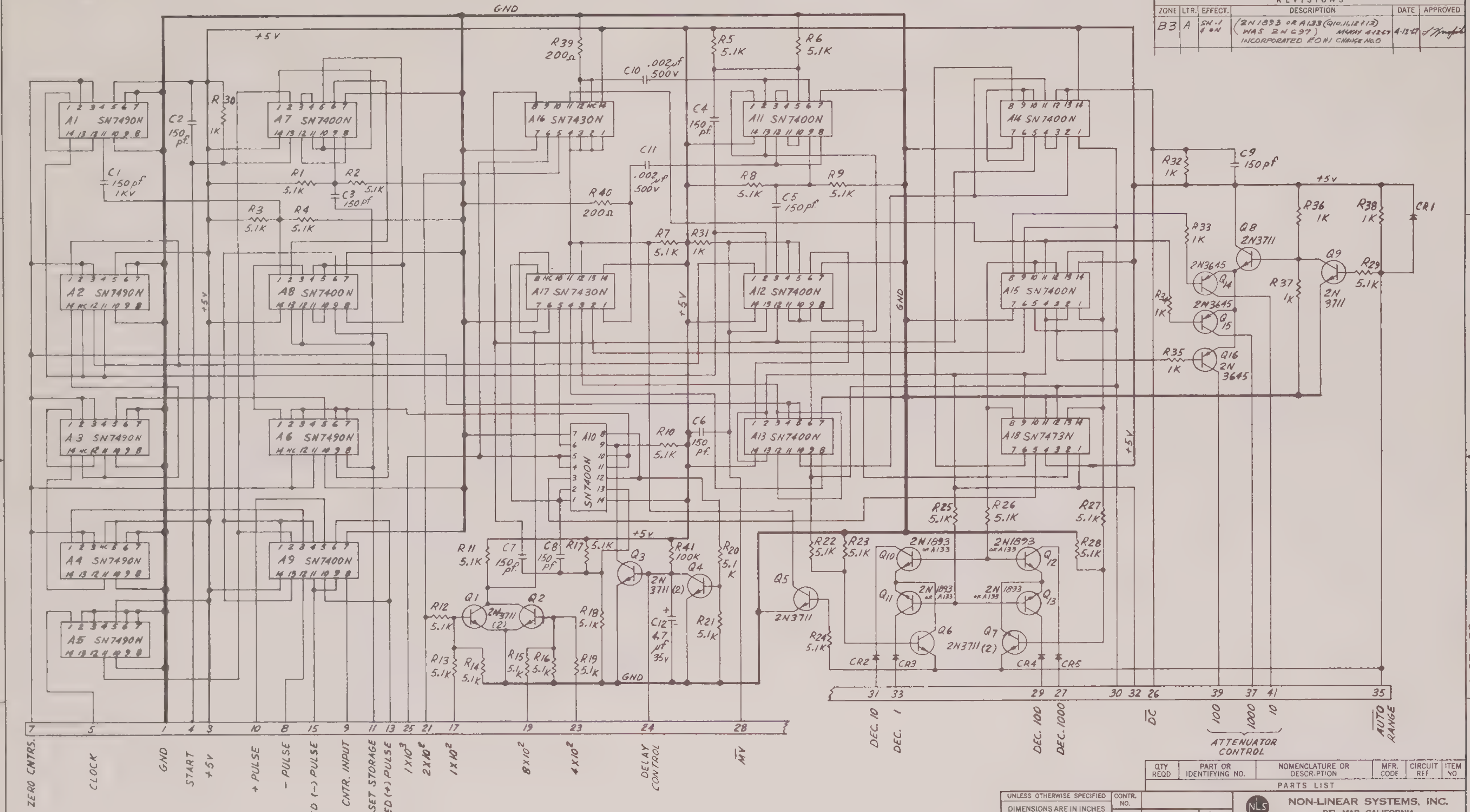
NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

SCHEMATIC - DECADE
SERIES X-2

SIZE D
CODE IDENT NO. 03626
37-30
SCALE
WEIGHT
SHEET 2 OF 3

11/60 DIETERICH-POST CLEARPRINT 1000H-10

REVISIONS					
ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED
B3	A	SN.1 & ON	(2N1893 OR A133 (Q10,11,12 & 13) (WAS 2N697) MKAY 4-12-67 INCORPORATED EO#1 CHANGE NO.0	4-12-67	S Knopfle


GND
+5V
A1 SN7490N
A2 SN7490N
A3 SN7490N
A4 SN7490N
A5 SN7490N
A7 SN7400N
A8 SN7400N
A6 SN7490N
A9 SN7400N
A16 SN7430N
A17 SN7430N
A10 SN7400N
A11 SN7400N
A12 SN7400N
A13 SN7400N
A14 SN7400N
A15 SN7400N
A18 SN7473N
C1 150pf 1KV
C2 150 pf.
R30 1K
R1 5.1K
R2 5.1K
C3 150pf
R3 5.1K
R4 5.1K
R39 200Ω
C10 .002µf 500V
C11 .002µf 500V
R40 200Ω
R5 5.1K
R6 5.1K
C4 150 pf.
R8 5.1K
R9 5.1K
C5 150pf.
R7 5.1K
R31 1K
R10 5.1K
C6 150 pf.
C7 150 pf.
C8 150 pf
R17 5.1K
R11 5.1K
R12 5.1K
R13 5.1K
R14 5.1K
R15 5.1K
R16 5.1K
R18 5.1K
R19 5.1K
Q1
Q2
2N3711 (2)
Q3
Q4
2N3711 (2)
R41 100K
R20 5.1K
R21 5.1K
C12 4.7µf 35V
Q5 2N3711
R22 5.1K
R23 5.1K
R24 5.1K
R25 5.1K
R26 5.1K
R27 5.1K
R28 5.1K
Q10 2N1893 or A133
Q11 2N1893 or A133
Q12 2N1893 or A133
Q13 2N1893 or A133
Q6
Q7
2N3711 (2)
CR2
CR3
CR4
CR5
R32 1K
C9 150pf
R33 1K
Q8 2N3711
R36 1K
R38 1K
CR1
Q9 2N3711
R29 5.1K
R37 1K
Q14 2N3645
Q15 2N3645
R34 1K
R35 1K
Q16 2N3645
7 ZERO CNTRS.
5 CLOCK
1 GND
4 START
3 +5V
10 + PULSE
8 − PULSE
15 GATED (−) PULSE
9 CNTR. INPUT
11 SET STORAGE
13 GATED (+) PULSE
25 1X10³
21 2X10²
17 1X10²
19 8X10²
23 4X10²
24 DELAY CONTROL
28 MV
31 DEC. 10
33 DEC. 1
29 DEC. 100
27 DEC. 1000
30
32
26 DC
39 100
37 1000
41 10
ATTENUATOR CONTROL
35 AUTO RANGE
8
7
6
5
4
3
2
1
D
C
B
A
37-33 SH2

2 DIODES ARE NLS 5003-002.
1. RESISTORS ARE ¼W, 5% CARBON.
NOTES: UNLESS OTHERWISE SPECIFIED

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF	ITEM NO

PARTS LIST

NEXT ASSY.	FINAL ASSY.	NEXT ASSY.	FINAL ASSY.
APPLICATION		QTY	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010
ANGLES ± 0° 30'
FRACTIONS ± 1/32
MATERIAL

CONTR. NO.		
DRAWN	WICKLAND	1-31-67
CHECK	S Knopfle	2 13 67
APPR		2-13 67
RELEASE DATE	2-13-67	

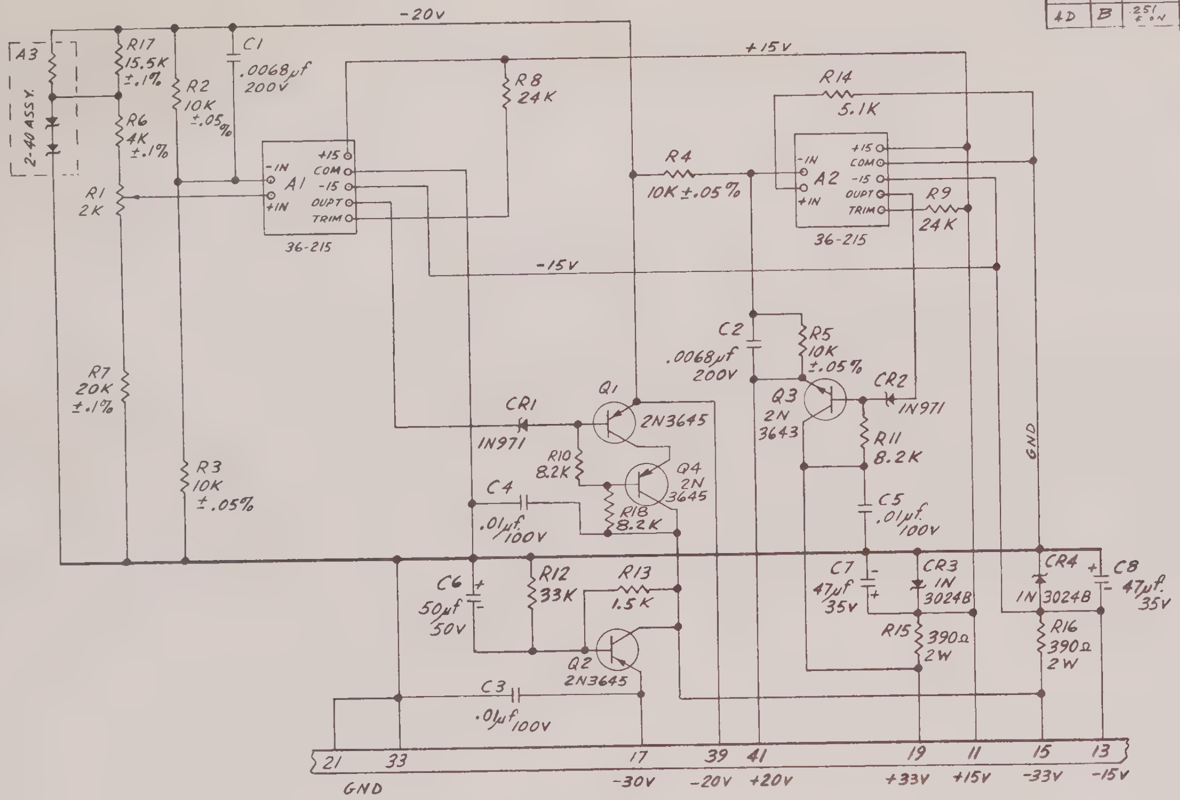
NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

START/STOP
& AUTO RANGE ASSEMBLY
X 2

SIZE	CODE IDENT NO.	
D	03626	37-33

SCALE
WEIGHT
SHEET 2 OF 3

REVISIONS					
ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED
3C	A	ALL	ADDED Q4 & R18 R.D.W.	2-23-67	R W J
4D	B	251 & ON	A3 (2-40ASSY) WAS 2-39 ASSY.	5-8-67	


A3
2-40 ASSY.
R17 15.5K ±.1%
R6 4K ±.1%
R1 2K
R2 10K ±.05%
C1 .0068µf 200V
-20V
+15V
R8 24K
R14 5.1K
-IN
+IN
A1
+15
COM
-15
OUPT
TRIM
36-215
R4 10K ±.05%
A2
R9 24K
-15V
R7 20K ±.1%
R3 10K ±.05%
C2 .0068µf 200V
R5 10K ±.05%
Q3 2N 3643
CR2 1N971
CR1 1N971
Q1 2N3645
R10 8.2K
Q4 2N 3645
R18 8.2K
C4 .01µf 100V
R11 8.2K
C5 .01µf 100V
GND
C6 50µf 50V
R12 33K
R13 1.5K
Q2 2N3645
C3 .01µf 100V
C7 47µf 35V
CR3 1N 3024B
R15 390Ω 2W
CR4 1N 3024B
R16 390Ω 2W
C8 47µf 35V
21
33
17
39
41
19
11
15
13
GND
-30V
-20V
+20V
+33V
+15V
-33V
-15V

37-36 SH2

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.

PARTS LIST

3. REFERENCE DESIGNATIONS ARE ABBREVIATED: PREFIX WITH ASSEMBLY DESIGNATION SHOWN ON SHEET 2 OF FINAL ASSEMBLY

2. RESISTORS R2 THRU R7 & R17 ARE NLS PW2016.

1. RESISTORS ARE 1/4 W, ±5%, CARBON.

NOTES: UNLESS OTHERWISE SPECIFIED

37-2	37-2	1	1
NEXT ASSY.	FINAL ASSY.	NEXT ASSY.	FINAL ASSY.
APPLICATION		QTY.	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ±.010
ANGLES ± 0° 30'
FRACTIONS ± 1/32

MATERIAL

CONTR. NO.		
DRAWN	WICKLAND	2-1-67
CHECK		2-16-67
APPR		2-16-67
RELEASE DATE		

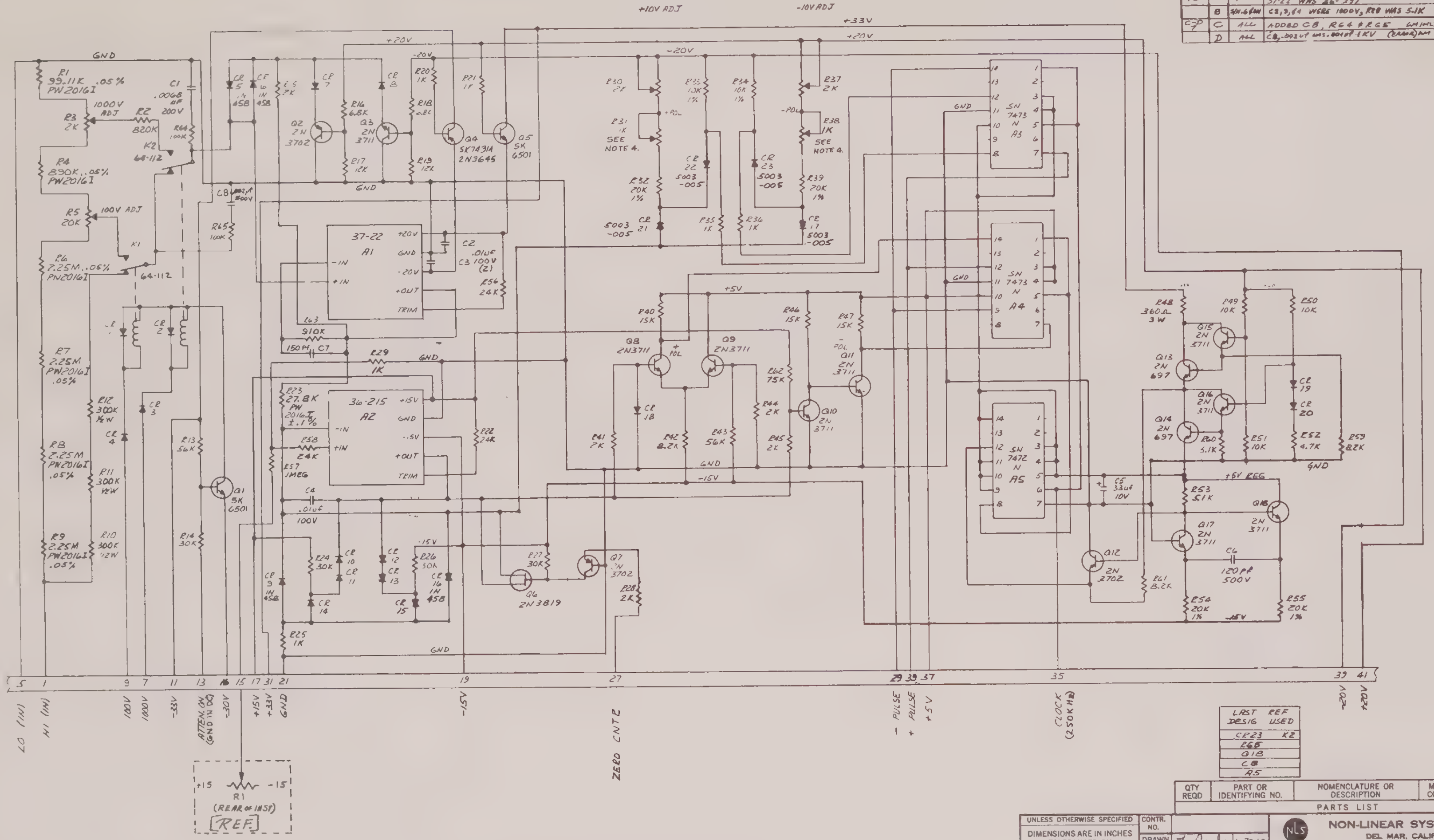
NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

-SCHEMATIC-
REFERENCE ASSEMBLY
X2

SIZE C
CODE IDENT NO. 03626
37-36
SCALE
WEIGHT
SHEET 2 OF 3

8/66 DIETERICH-POST CLEARPRINT 1000H-10

REVISIONS					
ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED
8B 7C	A	S/N. 6 & ON	R10, R11, R12, WAS 330K: REMOVED JUMPER AT R63 & ADDED R65 & C7 37-22 WAS 36-297	2-27-67 TO	2-27-67 RJ
	B	S/N. 6 & ON	C8, 9, 14 WERE 1000V, R28 WAS 5.1K	3-1-67 R.T.W.	3-1-67 R.T.W.
C-D 7	C	ALL	ADDED C8, R64 & R65 LM(MLT)	10-12-67	R.T.W.
	D	ALL	C8, .002uf WAS .001uf 1KV (ERROR) AM	10-20-67	R.T.W.



GND
R1 99.11K .05% PW2016I
R3 2K 1000V ADJ
R2 820K
C1 .0068 uf 200V
R64 100K
K2 64-112
R4 890K .05% PW2016I
R5 20K 100V ADJ
K1 64-112
R6 2.25M .05% PW2016I
R7 2.25M PW2016I .05%
R8 2.25M PW2016I .05%
R9 2.25M PW2016I .05%
R10 300K 1/2W
R11 300K 1/2W
R12 300K 1/2W
R13 56K
R14 30K
Q1 SK 6501
C8 .002uf 1KV
R65 100K
Q2 2N 3702
Q3 2N 3711
Q4 SK7431A 2N3645
Q5 SK 6501
R16 6.8K
R17 12K
R18 6.8K
R19 12K
R20 1K
R21 1K
+20V
-20V
+10V ADJ
-10V ADJ
+33V
37-22 A1
C2 .01uF
C3 100V (2)
R56 24K
R63 910K
C7 150pf
R29 1K
36-215 A2
R23 27.8K PW 2016I 1.1%
R58 24K
R57 1MEG
C4 .01uF 100V
R22 24K
R24 30K
R25 1K
R26 30K
Q6 2N3819
Q7 2N 3702
R27 30K
R28 2K
Q8 2N3711
Q9 2N3711
Q10 2N 3711
Q11 2N 3711
R40 15K
R41 2K
R42 8.2K
R43 56K
R44 2K
R45 2K
R46 15K
R47 15K
R62 75K
+POL
-POL
+5V
-15V
R30 2K
R31 1K SEE NOTE 4.
R32 20K 1%
R33 10K 1%
R34 10K 1%
R35 1K
R36 1K
R37 2K
R38 1K SEE NOTE 4.
R39 20K 1%
CR 21 5003 -005
CR 22 5003 -005
CR 23 5003 -005
CR 17 5003 -005
SN 7473 N A3
SN 7473 N A4
SN 7472 N A5
C5 33uf 10V
Q12 2N 2702
R61 8.2K
Q13 2N 697
Q14 2N 697
Q15 2N 3711
Q16 2N 3711
Q17 2N 3711
Q18 2N 3711
R48 360Ω 3W
R49 10K
R50 10K
R51 10K
R52 4.7K
R53 5.1K
R54 20K 1%
R55 20K 1%
R59 82K
R60 5.1K
C6 120pf 500V
+5V REG
LO (IN)
HI (IN)
100V
1000V
-33V
ATTEN.ON (GND IN DC)
-30V
+15V
+33V
GND
-15V
ZERO CNTR
- PULSE
+ PULSE
+5V
CLOCK (250KHz)
-20V
+20V
+15
-15
R1 (REAR of INST)
REF.

LAST DESIG	REF USED
CR23	K2
R65	
Q18	
C8	
A5	

4. FOR TEMPERATURE COMPENSATION ADJUSTMENT OF R31 & R38 SEE DOC. # 833
3. REFERENCE DESIGNATIONS ARE ABBREVIATED; PREFIX WITH ASSEMBLY DESIGNATION SHOWN ON SHEET 2 OF FINAL ASSEMBLY
2. ALL DIODES NLS 5003-002
1. ALL RES 1/4W, 5%

NOTES: UNLESS OTHERWISE SPECIFIED

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.

PARTS LIST

NEXT ASSY.	FINAL ASSY.	NEXT ASSY	FINAL ASSY.
37-4	37-4	1	1
37-2	37-2	1	1

APPLICATION | QTY

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010
FRACTIONS ± 1/32
ANGLES ± 0° 30'
MATERIAL

CONTR. NO.		
DRAWN	Tom Dencher	1-20-67
CHECK		2-27-67
APPR	R. Johnson	2-27-67
RELEASE DATE	2-27-67	

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

SCHEMATIC-
ATTENUATOR ASSY

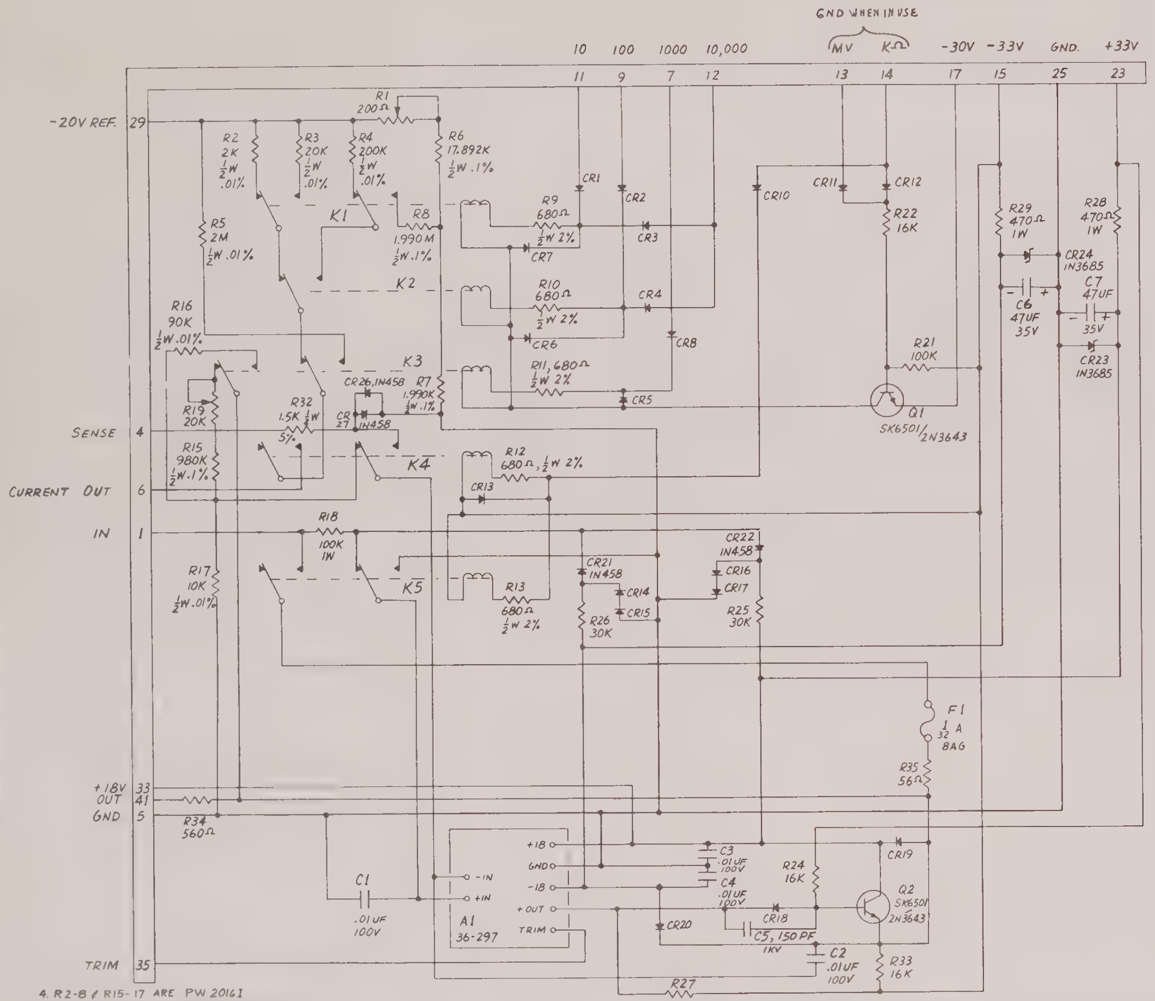
SERIES X-2

SIZE D | CODE IDENT NO. 03626 | 37-39

SCALE | WEIGHT | SHEET 2 OF 3

37-39 SH 2

REVISIONS					
ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED


GND WHEN IN USE
10
100
1000
10,000
MV
KΩ
-30V
-33V
GND.
+33V
11
9
7
12
13
14
17
15
25
23
-20V REF.
29
SENSE
4
CURRENT OUT
6
IN
1
+18V OUT
33
41
GND
5
TRIM
35
R1 200Ω
R2 2K ½W .01%
R3 20K ½W .01%
R4 200K ½W .01%
R5 2M ½W .01%
R6 17.892K ½W .1%
R7 1.990K ½W .1%
R8 1.990M ½W .1%
R9 680Ω ½W 2%
R10 680Ω ½W 2%
R11, 680Ω ½W 2%
R12 680Ω, ½W 2%
R13 680Ω ½W 2%
R15 980K ½W .1%
R16 90K ½W .01%
R17 10K ½W .01%
R18 100K 1W
R19 20K
R21 100K
R22 16K
R24 16K
R25 30K
R26 30K
R27 16K
R28 470Ω 1W
R29 470Ω 1W
R32 1.5K ½W 5%
R33 16K
R34 560Ω
R35 56Ω
K1
K2
K3
K4
K5
CR1
CR2
CR3
CR4
CR5
CR6
CR7
CR8
CR10
CR11
CR12
CR13
CR14
CR15
CR16
CR17
CR18
CR19
CR20
CR21 1N458
CR22 1N458
CR23 1N3685
CR24 1N3685
CR26, 1N458
CR27 1N458
C1 .01UF 100V
C2 .01UF 100V
C3 .01UF 100V
C4 .01UF 100V
C5, 150 PF 1KV
C6 47UF 35V
C7 47UF 35V
Q1 SK6501/2N3643
Q2 SK6501/2N3643
F1 1/32 A 8AG
A1 36-297
+18
GND
-18
+OUT
TRIM
-IN
+IN
8
7
6
5
4
3
2
1
A
B
C
D

OHMS RANGE RELAYS

RANGE	K1	K2	K3	K4	K5
1				X	X
10	X			X	X
100		X		X	X
1,000			X	X	X
10,000	X	X		X	X

LAST SYMBOL USED	
CAPACITOR	C7
DIODE	CR27
RESISTOR	R35

4. R2-8 & R15-17 ARE PW 2016I
3. REFERENCE DESIGNATIONS ARE ABBREVIATED; PREFIX WITH ASSEMBLY DESIGNATION SHOWN ON SHEET 2 OF FINAL ASSEMBLY
2. DIODES ARE 5003-002.
1. RESISTORS ARE ¼W, 5%.

NOTES: UNLESS OTHERWISE SPECIFIED

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.

PARTS LIST

NEXT ASSY.	FINAL ASSY.	NEXT ASSY	FINAL ASSY
APPLICATION		QTY	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010
ANGLES ± 0° 30'
FRACTIONS ± 1/32
MATERIAL

CONTR. NO.		
DRAWN	H BRINLEY	2-2-67
CHECK		3 28-67
APPR		
RELEASE DATE	3-28-67	

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

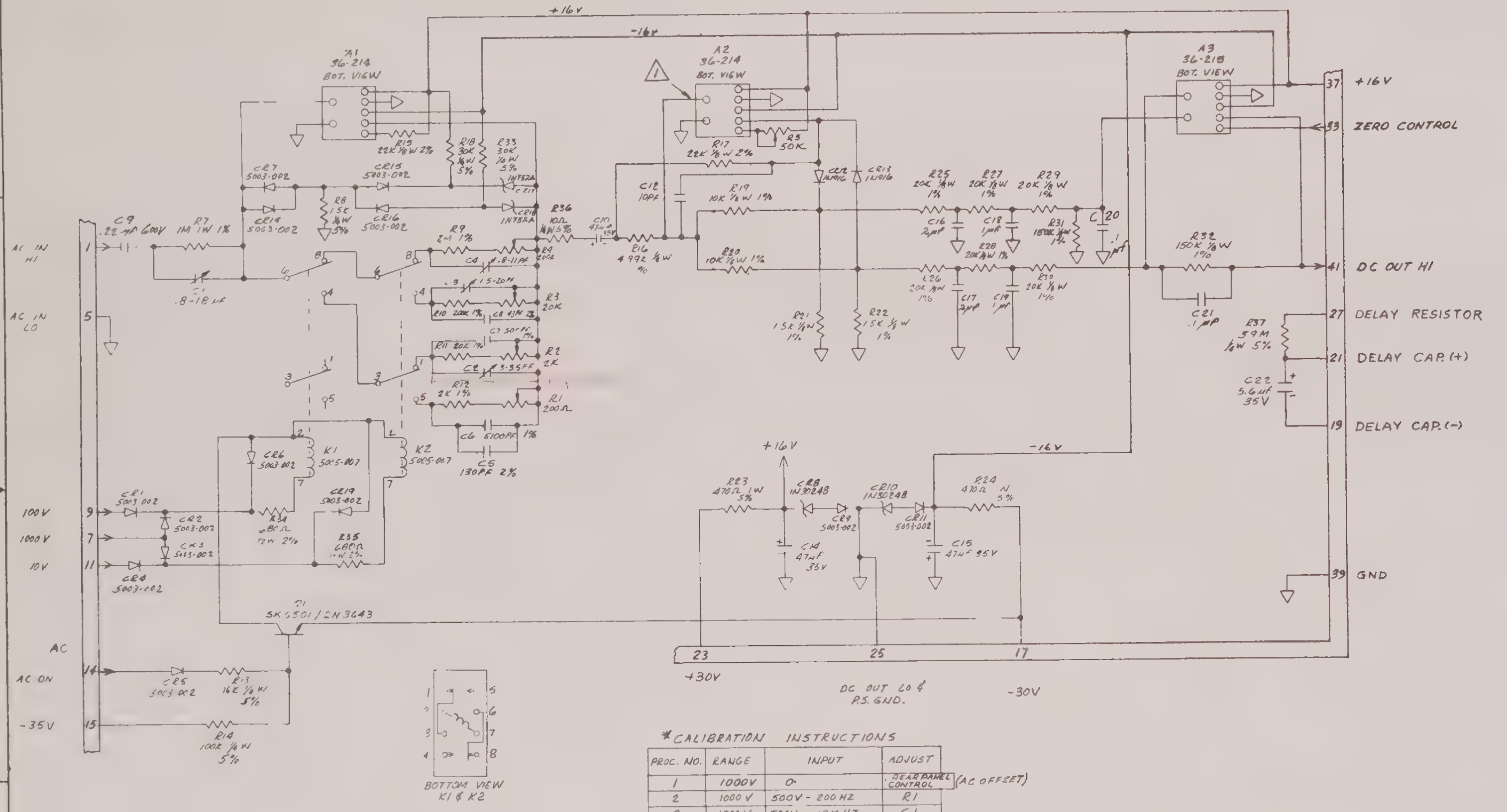
SCHEMATIC, PRE AMP &
KΩ/DC CONVERTER

X2 SERIES

SIZE D
CODE IDENT NO. 03626
37-42
SCALE
WEIGHT
SHEET 2 OF 3

37-42 SH.2

REVISIONS					
ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED
4C	A	ALL	C16 & 17 (2MF/200V) WERE 1MF/250V	3-13-67	



+16V
-16V
A1 36-214 BOT. VIEW
A2 36-214 BOT. VIEW
A3 36-218 BOT. VIEW
37 +16V
33 ZERO CONTROL
41 DC OUT HI
27 DELAY RESISTOR
21 DELAY CAP.(+)
19 DELAY CAP.(-)
39 GND
AC IN HI
AC IN LO
100V
1000V
10V
AC
AC ON
-35V
C9 .22 µF 600V
R7 1M 1W 1%
C1 .8-18 µF
R15 22K 1/8W 2%
R18 30K 1/8W 5%
R33 30K 1/8W 5%
CR7 5003-002
CR14 5003-002
CR15 5003-002
CR16 5003-002
CR17
CR18 1N752A
R8 15K 1/8W 5%
R36 10Ω 1/4W 5%
R9 2M 1%
C4 .8-11 PF
R4 200K
R3 20K
R10 20K 1%
C8 43PF 1%
C7 50 PF 1%
R11 20K 1%
C2 3-35 PF
R2 2K
R12 2K 1%
R1 200Ω
C6 5100 PF 1%
C5 130PF 2%
K1 5005-007
K2 5005-007
CR6 5003-002
R34 680Ω 1/2W 2%
CR19 5003-002
R35 680Ω 1/4W 2%
CR1 5003-002
CR2 5003-002
CR3 5003-002
CR4 5003-002
Q1 SK 5501 / 2N 3643
CR5 5003-002
R13 16K 1/8W 5%
R14 100K 1/4W 5%
C11 47 µF 15V
R16 4992 1/8W 1%
C12 10PF
R17 22K 1/8W 2%
R5 50K
R19 10K 1/8W 1%
R20 10K 1/8W 1%
CR12 1N916
CR13 1N916
R21 15K 1/4W 1%
R22 15K 1/4W 1%
R25 20K 1/8W 1%
R26 20K 1/8W 1%
R27 20K 1/8W 1%
R28 20K 1/8W 1%
R29 20K 1/8W 1%
R30 20K 1/8W 1%
R31 180K 1/8W 1%
C16 2 µF
C17 2 µF
C18 1 µF
C19 1 µF
C20 .1 µF
R32 150K 1/8W 1%
C21 .1 µF
R37 59M 1/4W 5%
C22 5.6 µF 35V
R23 470Ω 1W 5%
CR8 1N3024B
CR9 5003-002
CR10 1N3024B
CR11 5003-002
R24 470Ω 1W 5%
C14 47 µF 35V
C15 47 µF 35V
23
25
17
+30V
DC OUT LO & P.S. GND.
-30V
BOTTOM VIEW K1 & K2

AC RANGE RELAYS		
RANGE	K1	K2
10		X
100	X	
500	X	X

*CALIBRATION INSTRUCTIONS

PROC. NO.	RANGE	INPUT	ADJUST
1	1000V	0	REAR PANEL CONTROL (AC OFFSET)
2	1000 V	500V - 200 HZ	R1
3	1000 V	500V - 10K HZ	C1
4	100 V	100V - 200 HZ	R2
5	100 V	100V - 10K HZ	C2
6	10V	10V - 200 HZ	R3
7	10 V	10V - 10K HZ	C3
8	1V	1V - 200 HZ	R4
9	1V	1V - 10K HZ	C4

* ADJ HI RNG FIRST

⚠ THIS POINT SHOULD MEASURE 0v ± 1MV. IF NOT, ADJUST R5.

NOTES UNLESS OTHERWISE SPECIFIED

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.

PARTS LIST

NEXT ASSY.	FINAL ASSY.	NEXT ASSY	FINAL ASSY
APPLICATION		QTY.	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010
FRACTIONS ± 1/32
ANGLES ± 0° 30'

MATERIAL

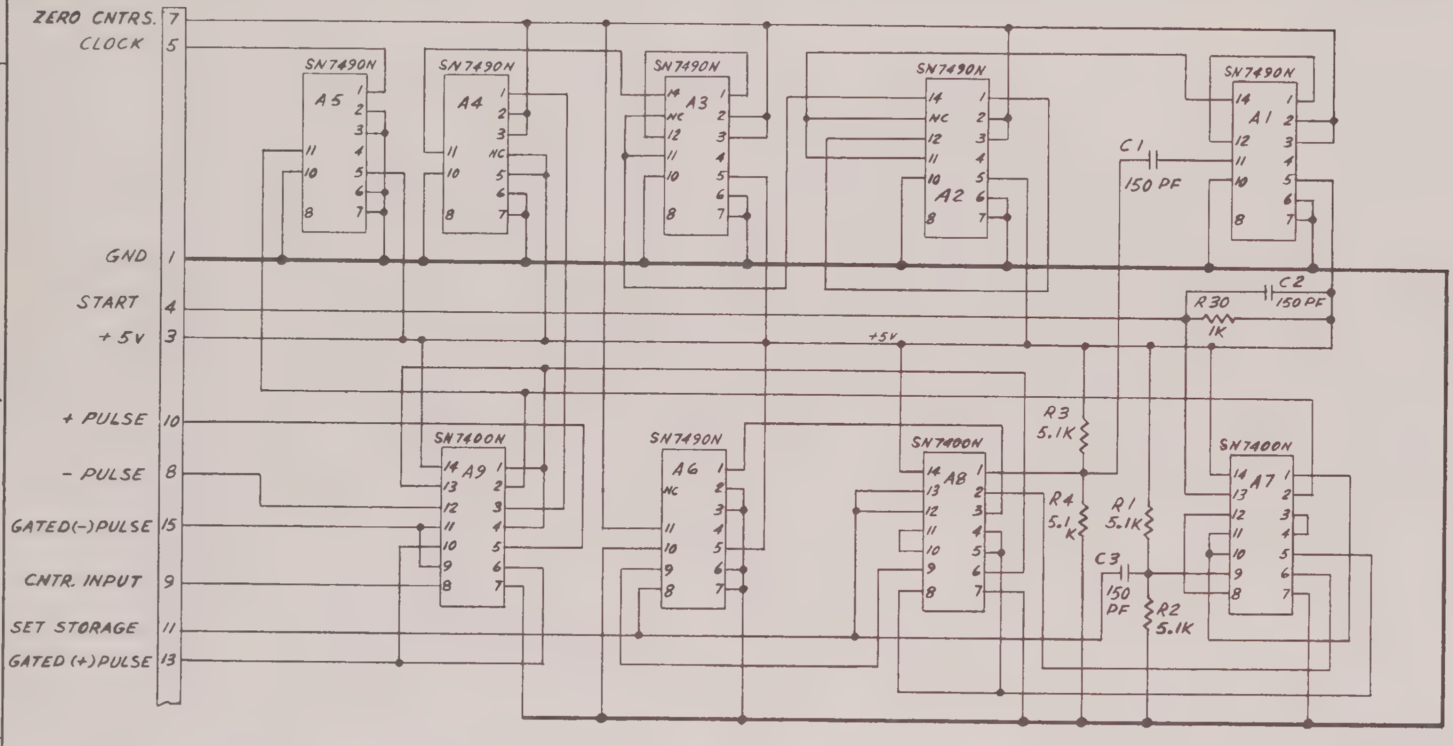
CONTR. NO.		
DRAWN	WICKLAND	2-1-67
CHECK		2-13-67
APPR		2-13-67
RELEASE DATE	2-13-67	

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

SCHEMATIC
AC/DC CONVERTER
SERIES X2

SIZE D
CODE IDENT NO. 03626
37-45
SCALE
WEIGHT
SHEET 2 OF 3

REVISIONS					
ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED
3B	A	ALL	CONNECTED A6-2,3,6,7 TO GND	2-17-67	


ZERO CNTRS. 7
CLOCK 5
GND 1
START 4
+ 5V 3
+ PULSE 10
- PULSE 8
GATED(-)PULSE 15
CNTR. INPUT 9
SET STORAGE 11
GATED (+)PULSE 13
SN7490N
A5
A4
A3
A2
A1
A6
SN7400N
A9
A8
A7
C1
150 PF
C2
150 PF
R30
1K
+5V
R3
5.1K
R4
5.1K
R1
5.1K
C3
150 PF
R2
5.1K
NC

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.

PARTS LIST

37-2	37-2	1	1
NEXT ASSY.	FINAL ASSY.	NEXT ASSY.	FINAL ASSY.
APPLICATION		QTY.	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010
FRACTIONS ± 1/32
ANGLES ± 0° 30'

MATERIAL

CONTR. NO.		
DRAWN	WICKLAND	2-3-67
CHECK		2-13-67
APPR		2-13-67
RELEASE DATE	2-13-67	

NLS
NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

START STOP
ASS'Y.

SERIES X2

SIZE C
CODE IDENT NO. 03626
37-69

SCALE
WEIGHT
SHEET 2 OF 3

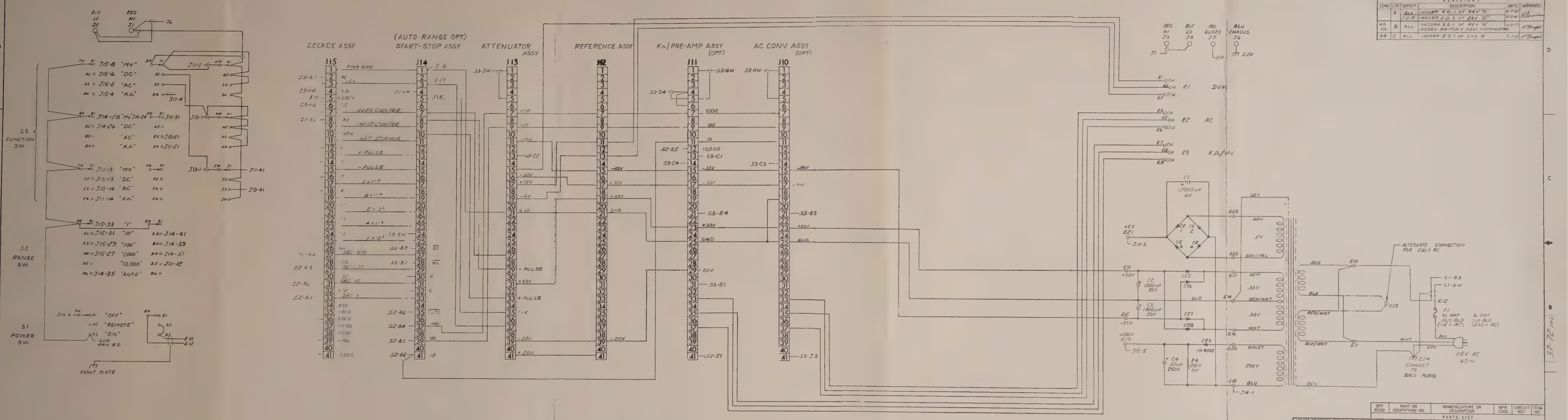
37-69 SH2

2. REFERENCE DESIGNATIONS ARE ABBREVIATED; PREFIX WITH ASSEMBLY DESIGNATION SHOWN ON SHEET 2 OF FINAL ASSEMBLY

1. RESISTORS ARE 1/4 W, 5%, CARBON.

NOTES: UNLESS OTHERWISE SPECIFIED

8/66 DIETERICH-POST CLEARPRINT 1000H-10


BLK LO J2
RED HI J1
J15-8 "MV"
J15-6 "DC"
J15-2 "AC"
J15-4 "KΩ"
J14-28 "MV"
J14-26 "DC"
"AC"
"KΩ"
S3 FUNCTION SW
J11-13 "MV"
J15-13 "DC"
J10-14 "AC"
J11-14 "KΩ"
J15-33 "1"
J15-31 "10"
J15-29 "100"
J15-27 "1000"
"10,000"
J14-35 "AUTO"
J14-41
J14-39
J14-37
J11-12
S2 RANGE SW.
S1 POWER SW.
"OFF"
"REMOTE"
"ON"
GND MAIN BD
FRONT PLATE
DECADE ASSY
(AUTO RANGE OPT.) START-STOP ASSY
ATTENUATOR ASSY
REFERENCE ASSY
KΩ/PRE-AMP ASSY (OPT)
AC CONV ASSY (OPT)
J15
J14
J13
J12
J11
J10
PWR GND
ZERO COUNTER
INIT COUNTER
SET STORAGE
+ PULSE
- PULSE
- PULSE
+ PULSE
GND
+33V
-33V
-20V
+15V
-15V
10,000
1000
100
10
RED HI J1
BLK LO J4
YEL GUARD J5
BLU CHASSIS J6
E1 DVM
E2 AC
E3 KΩ/MV
C1 12000uF 6V
C2 1300uF 50V
C3 1300uF 50V
C4 50uF 250V
R4 200K 5W
CR9 1N4005
+5V E21
J14-3
+33V
-33V
+200V E19
J15-5
GRY
GRN
5V
GRN/YEL
GRN/WHT
33V
WHT
VIOLET
200V
BLU
J14-1
RED
BLK
RED/WHT
BLU/WHT
ALTERNATE CONNECTION FOR 230V AC
S1-B3
S1-B4
F1 1/2 AMP SLO-BLO (115V AC)
1/4 AMP SLO-BLO (230V AC)
115V AC 60~
E24 CONNECT TO BACK PLATE

ZONE	LTR	EFFECT	DESCRIPTION	DATE	APPROVED
	A	ALL	INCORP. E.O. 1 OF REV 'O'	4-11-67	RBrown
		C.O.P.	INCORP. E.O. 2 OF REV 'O'	RDW	
4D F/D	B	ALL	INCORP E.O 1 OF REV "A" ADDED SWITCH & ASSY NOMENCLATURE	11-21-67	
5B	C	ALL	INCORP E.O. 1 OF CHG 'B'	3-9-68	

1 ALL DIODES ARE 1N4003

NOTES UNLESS OTHERWISE SPECIFIED

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF	ITEM NO

PARTS LIST

37-2	37-2	1	1
NEXT ASSY	FINAL ASSY	NEXT ASSY	FINAL ASSY
APPLICATION		QTY	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ±.010
FRACTIONS ±1/32
ANGLES ±0°30'

MATERIAL

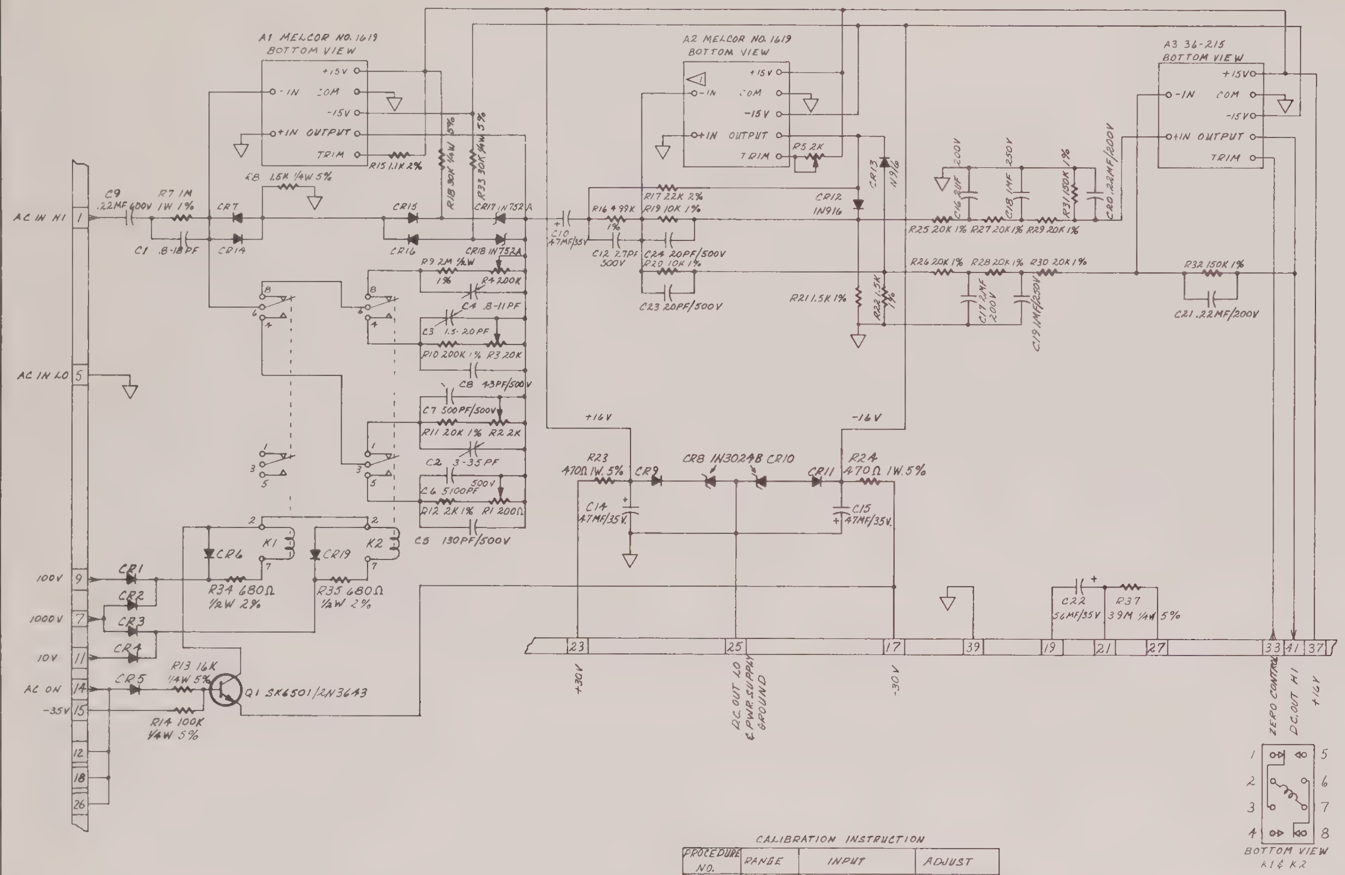
CONTR. NO.		
DRAWN		2-1-67
CHECK		2-2-67
APPR	R Jonassen	2-10-67
RELEASE DATE	2-10-67	

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

SCHEMATIC -
MAIN BOARD AND POWER SUPPLY
SERIES X-2

SIZE R
CODE IDENT NO. 03626
37-72
SCALE None
WEIGHT
SHEET 2 OF 3

REVISIONS					
ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED
B B	A	S/N .261 ON	ADDED CONNECTIONS AT PINS 12, 18 & 26. 5-11-67 DW.	5-12-67	


A1 MELCOR NO. 1619
BOTTOM VIEW
+15V
-IN
COM
-15V
+IN
OUTPUT
TRIM
R15 1.1K 2%
R18 30K 1/4W 5%
R33 30K 1/4W 5%
R8 1.5K 1/4W 5%
AC IN HI
AC IN LO
C9 .22MF 600V
R7 1M 1W 1%
C1 .8-18PF
CR7
CR14
CR15
CR16
CR17 1N752A
CR18 1N752A
C10 47MF/35V
R9 2M 1/2W 1%
R4 200K
C4 .8-11PF
C3 1.5-20PF
R10 200K 1%
R3 20K
C8 43PF/500V
C7 500PF/500V
R11 20K 1%
R2 2K
C2 3-35PF
C6 5100PF 500V
R12 2K 1%
R1 200Ω
C5 130PF/500V
K1
K2
CR6
CR19
R34 680Ω 1/2W 2%
R35 680Ω 1/2W 2%
100V
1000V
10V
AC ON
-35V
CR1
CR2
CR3
CR4
CR5
R13 16K 1/4W 5%
R14 100K 1/4W 5%
Q1 SK6501/2N3643
A2 MELCOR NO. 1619
BOTTOM VIEW
R5 2K
R16 4.99K 1%
R17 22K 2%
R19 10K 1%
C12 2.7PF 500V
C24 20PF/500V
R20 10K 1%
C23 20PF/500V
CR12 1N916
CR13 1N916
R21 1.5K 1%
R22 1.5K 1%
R25 20K 1%
R27 20K 1%
R29 20K 1%
C16 2UF 200V
C18 1MF 250V
R31 150K 1%
C20 .22MF/200V
R26 20K 1%
R28 20K 1%
R30 20K 1%
C17 2MF 200V
C19 1MF/250V
A3 36-215
BOTTOM VIEW
R32 150K 1%
C21 .22MF/200V
+16V
-16V
R23 470Ω 1W 5%
R24 470Ω 1W 5%
CR8 1N3024B CR10
CR9
CR11
C14 47MF/35V
C15 47MF/35V
C22 56MF/35V
R37 39M 1/4W 5%
1
5
9
7
11
14
15
12
18
26
23
25
17
39
19
21
27
33
41
37
+30V
DC OUT LO & PWR SUPPLY GROUND
-30V
ZERO CONTROL
DC OUT HI
+16V
BOTTOM VIEW K1 & K2

6. ALL RELAYS ARE 5005-007
5 ALL RESISTORS ARE 1/8W
4 ALL DIODES ARE NLS 5003-002
3. AFTER CALIBRATION, SPOT CHECK AT VARIOUS FREQUENCIES THROUGHOUT BAND WIDTH OF CONVERTER.
2. REFERENCE DESIGNATIONS ARE ABBREVIATED; PREFIX WITH ASSEMBLY DESIGNATION SHOWN ON SHEET 2 OF FINAL ASSEMBLY
◁1 THIS POINT SHOULD MEASURE 0V ± 1MV. ADJUST R5 FOR CORRECTION.
NOTES UNLESS OTHERWISE SPECIFIED

CALIBRATION INSTRUCTION

PROCEDURE NO.	RANGE	INPUT	ADJUST
1	1000V	0	REAR PANEL CONTROL (AC OFFSET)
2	1000V	500V - 200HZ	R1
3	1000V	500V - 80KHZ	C1
4	100V	100V - 200HZ	R2
5	100V	100V - 80KHZ	C2
6	10V	10V - 200HZ	R3
7	10V	10V - 80KHZ	C3
8	1V	1V - 200HZ	R4
9	1V	1V - 80KHZ	C4

QTY REQD	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MFR CODE	CIRCUIT REF.	ITEM NO.

PARTS LIST

NEXT ASSY.	FINAL ASSY.	NEXT ASSY.	FINAL ASSY.
APPLICATION		QTY	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010
FRACTIONS ± 1/32
ANGLES ± 0° 30'
MATERIAL

CONTR NO.		
DRAWN	J.A. COMBS	3-16-67
CHECK		3-27-67
APPR	P. Johnson	3-28-67
RELEASE DATE	3-28-67	

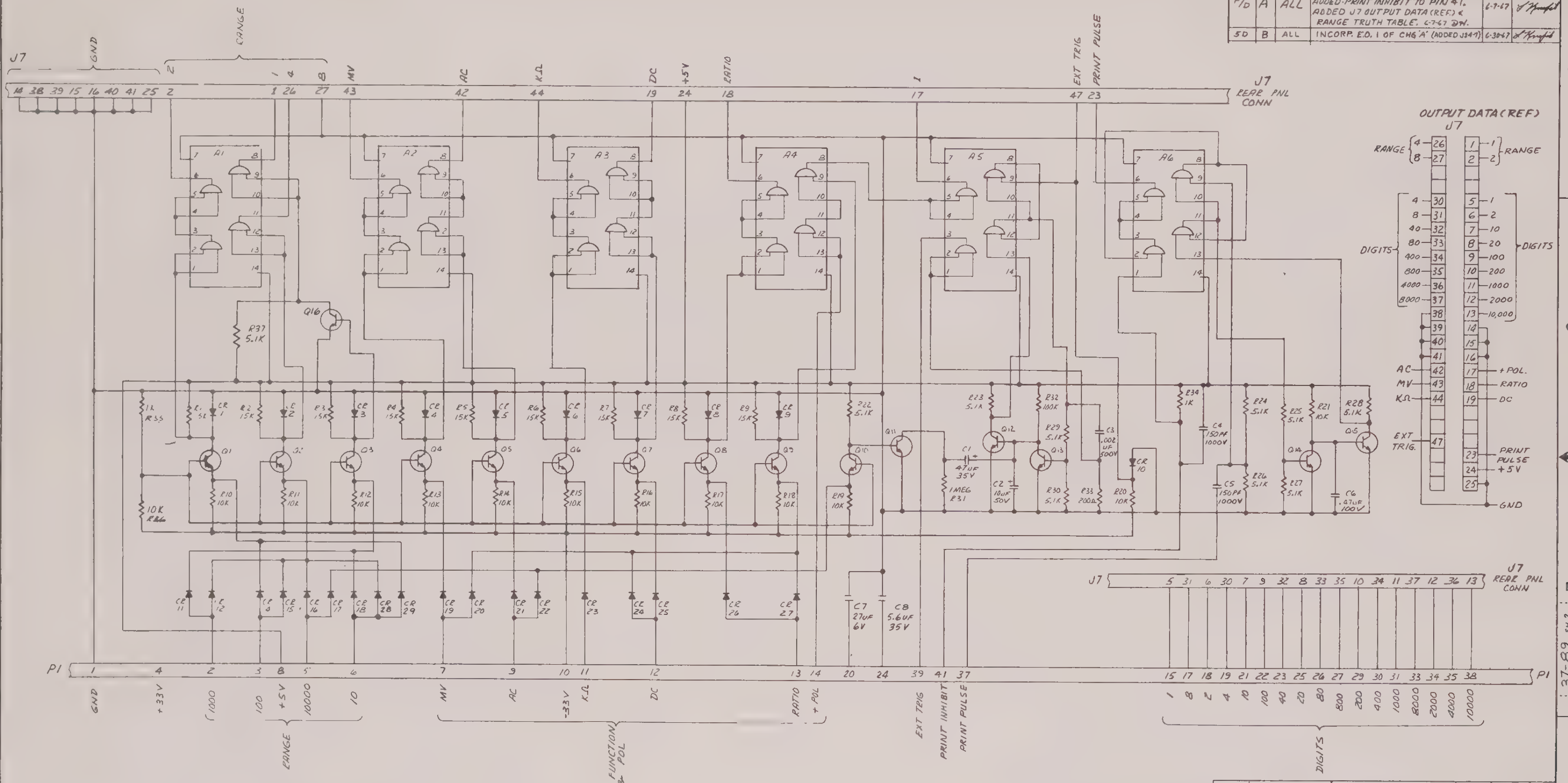
NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

SCHEMATIC
100KHZ AC/DC CONVERTER
SERIES X-2

SIZE D
CODE IDENT NO. 03626
37-77
SCALE
WEIGHT
SHEET 2 OF 3

37-77 SH 2

ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED
F/D	A	ALL	CHG - "PRINT PULSE" FROM PIN 41 TO 37, ADDED "PRINT INHIBIT" TO PIN 41. ADDED J7 OUTPUT DATA (REF.) & RANGE TRUTH TABLE. 6-7-67 DW.	6-7-67	L. Krafel
5D	B	ALL	INCORP. E.O. 1 OF CHG 'A' (ADDED J24-7)	6-30-67	L. Krafel


J7
GND
RANGE
14 38 39 15 16 40 41 25 2
2
1 4 8
1 26 27
MV 43
AC 42
KΩ 44
DC 19
+5V 24
RATIO 18
1 17
EXT TRIG 47
PRINT PULSE 23
J7 REAR PNL CONN
A1
A2
A3
A4
A5
A6
Q16
R37 5.1K
1K R35
R1 5K
R2 15K
R3 15K
R4 15K
R5 15K
R6 15K
R7 15K
R8 15K
R9 15K
CR 1
CR 2
CR 3
CR 4
CR 5
CR 6
CR 7
CR 8
CR 9
Q1
Q2
Q3
Q4
Q5
Q6
Q7
Q8
Q9
Q10
Q11
Q12
Q13
Q14
Q15
10K R36
R10 10K
R11 10K
R12 10K
R13 10K
R14 10K
R15 10K
R16 10K
R17 10K
R18 10K
R19 10K
R22 5.1K
R23 5.1K
R32 100K
R29 5.1K
C1 47uF 35V
1MEG R31
C2 10uF 50V
R30 5.1K
R33 200Ω
C3 .002 uF 500V
CR 10
R20 10K
R34 1K
C4 150PF 1000V
C5 150PF 1000V
R24 5.1K
R26 5.1K
R25 5.1K
R27 5.1K
R21 10K
R28 5.1K
C6 .47uF 100V
CR 11
CR 12
CR 6
CR 15
CR 16
CR 17
CR 18
CR 28
CR 29
CR 19
CR 20
CR 21
CR 22
CR 23
CR 24
CR 25
CR 26
CR 27
C7 27uF 6V
C8 5.6uF 35V
J7
5 31 6 30 7 9 32 8 33 35 10 34 11 37 12 36 13
J7 REAR PNL CONN
P1
1 4 2 3 8 5 6 7 9 10 11 12 13 14 20 24 39 41 37 15 17 18 19 21 22 23 25 26 27 29 30 31 33 34 35 38
GND
+33V
1000
100
+5V
10000
10
RANGE
MV
AC
-33V
KΩ
DC
RATIO
+POL
FUNCTION & POL
EXT TRIG
PRINT INHIBIT
PRINT PULSE
1 8 2 4 10 100 40 20 80 800 200 400 1000 8000 2000 4000 10000
DIGITS
OUTPUT DATA (REF)
J7
RANGE 4 26
RANGE 8 27
1 1 RANGE
2 2
4 30
8 31
40 32
80 33
400 34
800 35
4000 36
8000 37
DIGITS
5 1
6 2
7 10
8 20
9 100
10 200
11 1000
12 2000
13 10,000
DIGITS
38
39
40
41
AC 42
MV 43
KΩ 44
EXT TRIG. 47
14
15
16
17 +POL.
18 RATIO
19 DC
23 PRINT PULSE
24 +5V
25
GND

RANGE TRUTH TABLE +5V=TRUE

		8	4	2	1	DISCRETE NUMBER
0.XXXX	1		1			4
0X.XXX	10			1	1	3
0XX.XX	100			1		2
0XXX.X	1000				1	1
0XXXX	10000					0

5. ALL DIP 2N7400N
4 ALL RESISTORS 1/4W, 5%
3. ALL TRANSISTORS 2N3711
2 ALL DIODES NLS 5003-002
1. REFERENCE DESIGNATIONS ARE ABBREVIATED; PREFIX WITH ASSEMBLY DESIGNATION SHOWN ON SHEET 2 OF FINAL ASSEMBLY

NOTES: UNLESS OTHERWISE SPECIFIED

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO

PARTS LIST

37-5	37-5	1	1
NEXT ASSY.	FINAL ASSY.	NEXT ASSY.	FINAL ASSY
APPLICATION		QTY.	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010
ANGLES ± 0° 30'
FRACTIONS ± 1/32
MATERIAL

CONTR. NO.
DRAWN Wenchr 3/31/67
CHECK L. Krafel 5-3-67
APPR 5-5-67
RELEASE DATE 5-5-67

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

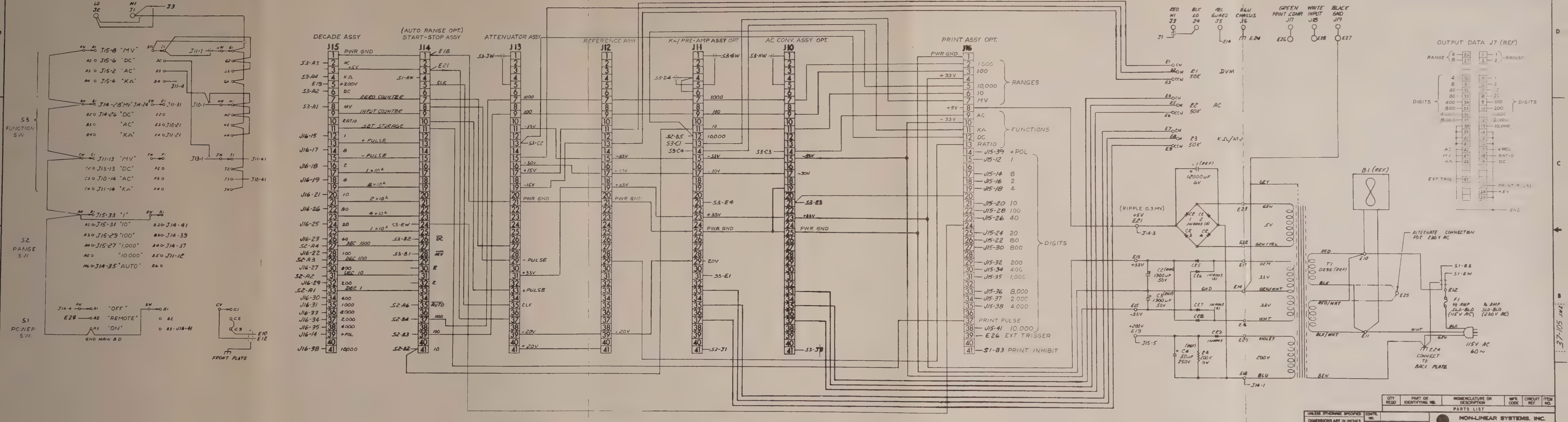
ASSY, PRINT BOARD
SCHEMATIC

SERIES X-2

SIZE D
CODE IDENT NO. 03626
37-89
SCALE
WEIGHT
SHEET 2 OF 3

37-89 SH 2

ZONE	LTR	EFFECT	DESCRIPTION	DATE	APPROVED
5B	A	ALL	INCORP EO 1 OF CHG "O"	3-10-68	



S3 FUNCTION SW
S2 RANGE SW
S1 POWER SW
"MV" "DC" "AC" "KΩ"
"1" "10" "100" "1,000" "10,000" "AUTO"
"OFF" "REMOTE" "ON"
GND MAIN BD
FRONT PLATE
DECADE ASSY J15
(AUTO RANGE OPT.) START-STOP ASSY J14
ATTENUATOR ASSY J13
REFERENCE ASSY J12
KΩ PRE-AMP ASSY OPT J11
AC CONV. ASSY OPT. J10
PRINT ASSY OPT. J16
PWR GND
ZERO COUNTER
INPUT COUNTER
SET STORAGE
+ PULSE
- PULSE
PRINT PULSE
E26 EXT TRIGGER
S1-B3 PRINT INHIBIT
RANGES
FUNCTIONS
DIGITS
+POL
RED HI J3
BLK LO J4
YEL GUARD J5
BLU CHASSIS J6
GREEN PRINT COMP J17
WHITE INPUT J18
BLACK GND J19
DVM
OUTPUT DATA J7 (REF)
RANGE
DIGITS
EXT TRIG
PRINT
GND
B1 (REF)
(RIPPLE 0.3 MV)
C1 (REF) 12000 uF 6V
C2 (REF) 1900 uF 50V
C3 (REF) 1900 uF 50V
C4 (REF) 50 uF 250V
T1 0236 (REF)
ALTERNATE CONNECTION FOR 230V AC
F1 1/2 AMP SLO-BLO (115V AC)
1/4 AMP SLO-BLO (230V AC)
115V AC 60~
CONNECT TO BACK PLATE

PARTS LIST

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.

NEXT ASSY.	FINAL ASSY.	NEXT ASSY	FINAL ASSY.
37-5	37-5	1	1

APPLICATION QTY.

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010
ANGLES ± 0° 30'
FRACTIONS ± 1/32
MATERIAL

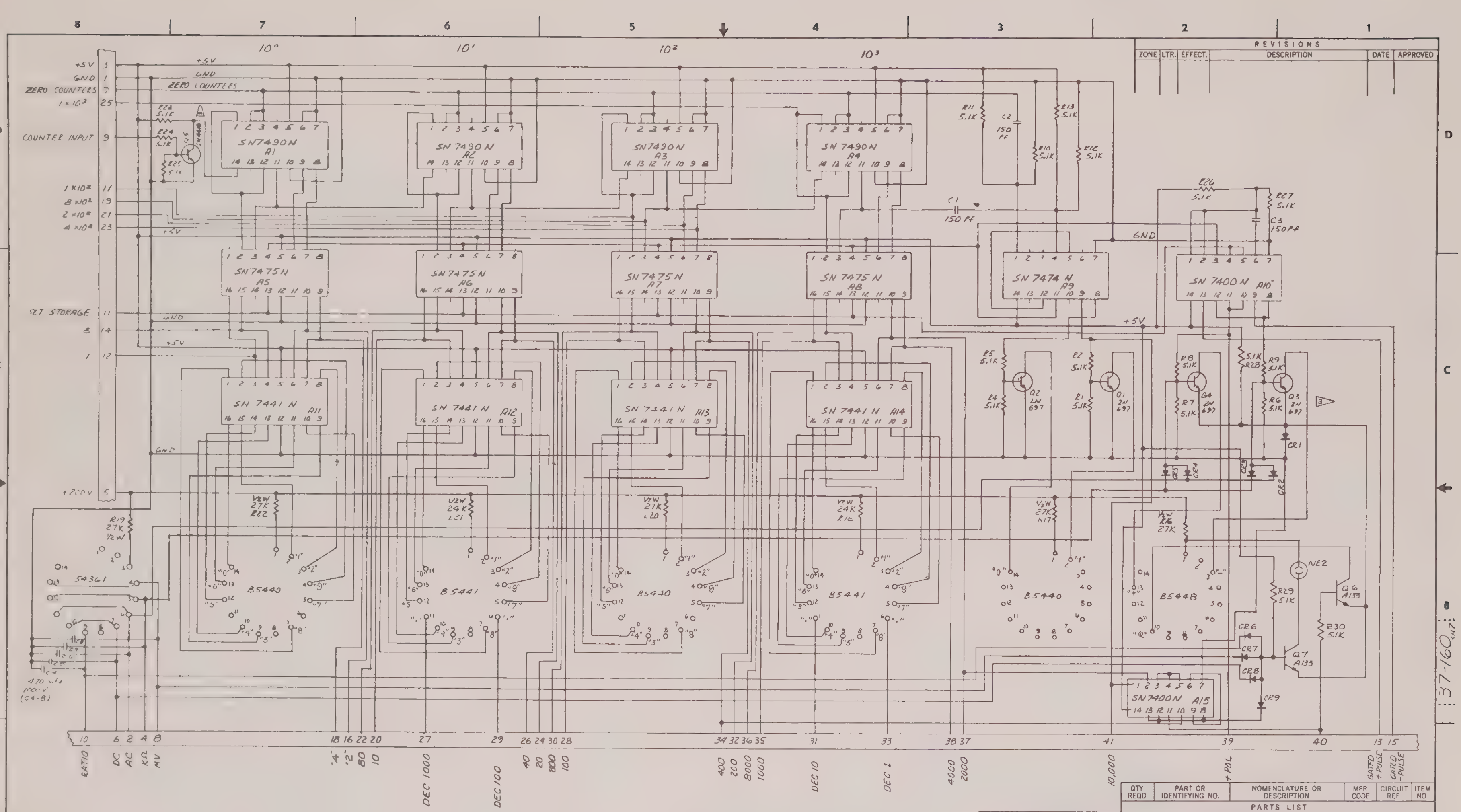
CONTR. NO.
DRAWN WEINBERG 4-19-67
CHECK 6-5-67
APPR 6-6-67
RELEASE DATE 6-6-67

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

SCHEMATIC -
MAIN BOARD AND POWER SUPPLY
SERIES X-2 W/PRINT

SIZE R CODE IDENT NO. 03626 37-105
SCALE None WEIGHT SHEET 2 of 2

REVISIONS					
ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED



8
7
6
5
4
3
2
1
D
C
B
A
10°
10'
10²
10³
+5V 3
GND 1
ZERO COUNTERS 7
1×10³ 25
COUNTER INPUT 9
1×10² 11
8×10² 19
2×10² 21
4×10² 23
SET STORAGE 11
8 14
1 12
+200V 5
+5V
GND
ZERO COUNTERS
R24 5.1K
R23 5.1K
R25 5.1K
Q5
SN7490N A1
SN7490N A2
SN7490N A3
SN7490N A4
SN7475N A5
SN7475N A6
SN7475N A7
SN7475N A8
SN7474N A9
SN7400N A10
SN7441N A11
SN7441N A12
SN7441N A13
SN7441N A14
SN7400N A15
R11 5.1K
C2 150 PF
R13 5.1K
R10 5.1K
R12 5.1K
C1 150 PF
R26 5.1K
R27 5.1K
C3 150 PF
R5 5.1K
R4 5.1K
Q2 2N 697
R2 5.1K
R1 5.1K
Q1 2N 697
R8 5.1K
R7 5.1K
Q4 2N 697
5.1K R28
R9 5.1K
R6 5.1K
Q3 2N 697
CR1
CR2
CR3
CR4
CR5
R19 27K 1/2W
5A361
470 µfd 100 V (C4-8)
1/2W 27K R22
1/2W 24K R21
1/2W 27K R20
1/2W 24K R18
1/2W 27K R17
1/2W 27K
B5440
B5441
B5440
B5441
B5440
B5448
NE2
R29 51K
R30 5.1K
Q6 A133
Q7 A133
CR6
CR7
CR8
CR9
10
6 2 4 8
18 16 22 20
27
29
26 24 30 28
34 32 36 35
31
33
38 37
41
39
40
13 15
RATIO
DC
AC
KΩ
MV
"4"
"2"
80
10
DEC 1000
DEC 100
40
20
800
100
400
200
8000
1000
DEC 10
DEC 1
4000
2000
10,000
+POL
GATED +PULSE
GATED -PULSE
37-160

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR CODE	CIRCUIT REF	ITEM NO

PARTS LIST

NEXT ASSY	FINAL ASSY.	NEXT ASSY	FINAL ASSY
APPLICATION		QTY	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010
FRACTIONS ± 1/32
ANGLES ± 0° 30'

MATERIAL

CONTR. NO.		
DRAWN	Hanrahan	6-23-67
CHECK	D. Hanrahan	7-6-67
APPR		7-6-67
RELEASE DATE	7-6-67 Ⓐ	

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

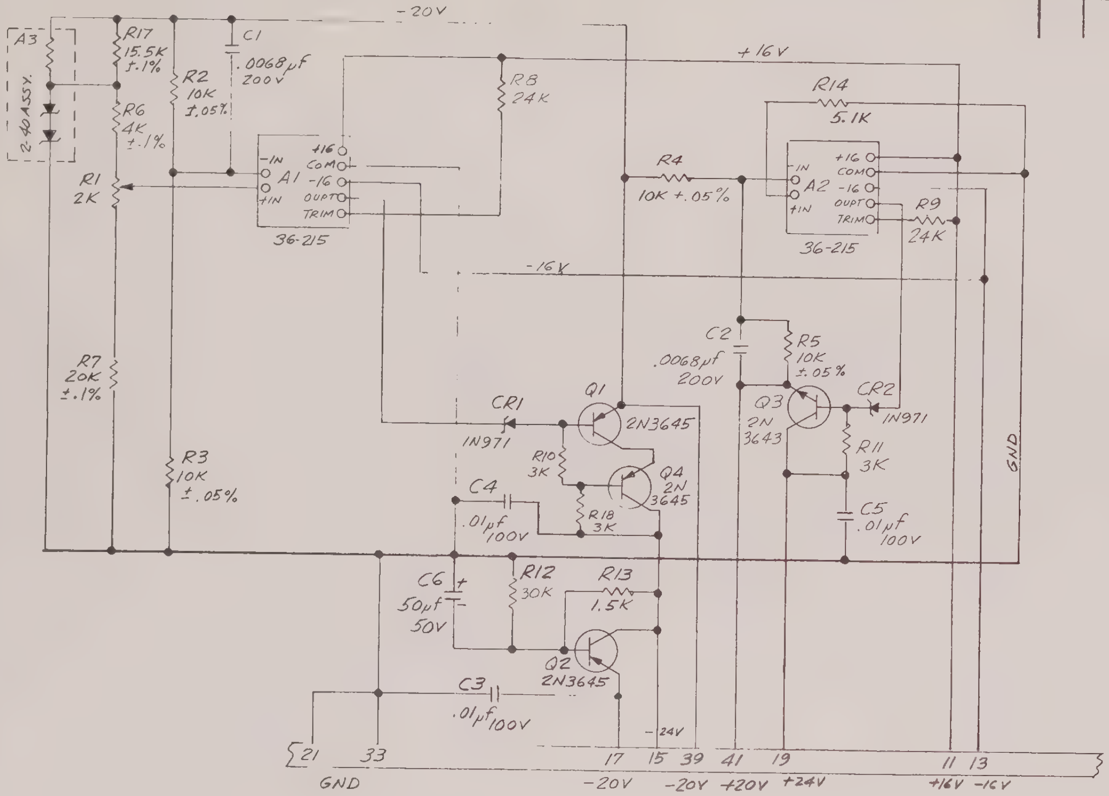
SCHEMATIC -
DECADE
SERIES X-2

SIZE D
CODE IDENT NO. 03626
37-160
SCALE
WEIGHT
SHEET 2 OF 2

3. Q1-4 ALTERNATE: A-133 AMPEREX
2. Q5 ALTERNATE · 2N2368 T.I.
1. REFERENCE DESIGNATIONS ARE ABBREVIATED; PREFIX WITH ASSEMBLY DESIGNATION SHOWN ON SHEET 2 OF FINAL ASSEMBLY

NOTES: UNLESS OTHERWISE SPECIFIED

REVISIONS					
ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED


-20V
A3
2-40 ASSY.
R17
15.5K
±.1%
R6
4K
±.1%
R1
2K
R2
10K
±.05%
C1
.0068µf
200V
-IN
+IN
A1
+16
COM
-16
OUPT
TRIM
36-215
R8
24K
+16V
R4
10K ±.05%
R14
5.1K
-IN
+IN
A2
+16
COM
-16
OUPT
TRIM
36-215
R9
24K
-16V
C2
.0068µf
200V
R5
10K
±.05%
Q3
2N
3643
CR2
1N971
R11
3K
C5
.01µf
100V
GND
R7
20K
±.1%
R3
10K
±.05%
CR1
1N971
Q1
2N3645
R10
3K
Q4
2N
3645
R18
3K
C4
.01µf
100V
C6
50µf
50V
R12
30K
R13
1.5K
Q2
2N3645
C3
.01µf
100V
-24V
21
33
GND
17
-20V
15
39
-20V
41
+20V
19
+24V
11
+16V
13
-16V

37-272 SH2

3. REFERENCE DESIGNATIONS ARE ABBREVIATED; PREFIX WITH ASSEMBLY DESIGNATION SHOWN ON SHEET 2 OF FINAL ASSEMBLY

2. RESISTORS R2 THRU R7 & R17 ARE NLS PW2016

1. RESISTORS ARE 1/4 W, ±5%, CARBON.

NOTES: UNLESS OTHERWISE SPECIFIED

8/66 DIETERICH-POST CLEARPRINT 1000H-10

APPLICATION		QTY.	
37-272	37-98	1	1
NEXT ASSY.	FINAL ASSY.	NEXT ASSY.	FINAL ASSY.

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.

PARTS LIST

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010
FRACTIONS ± 1/32
ANGLES ± 0° 30'

MATERIAL

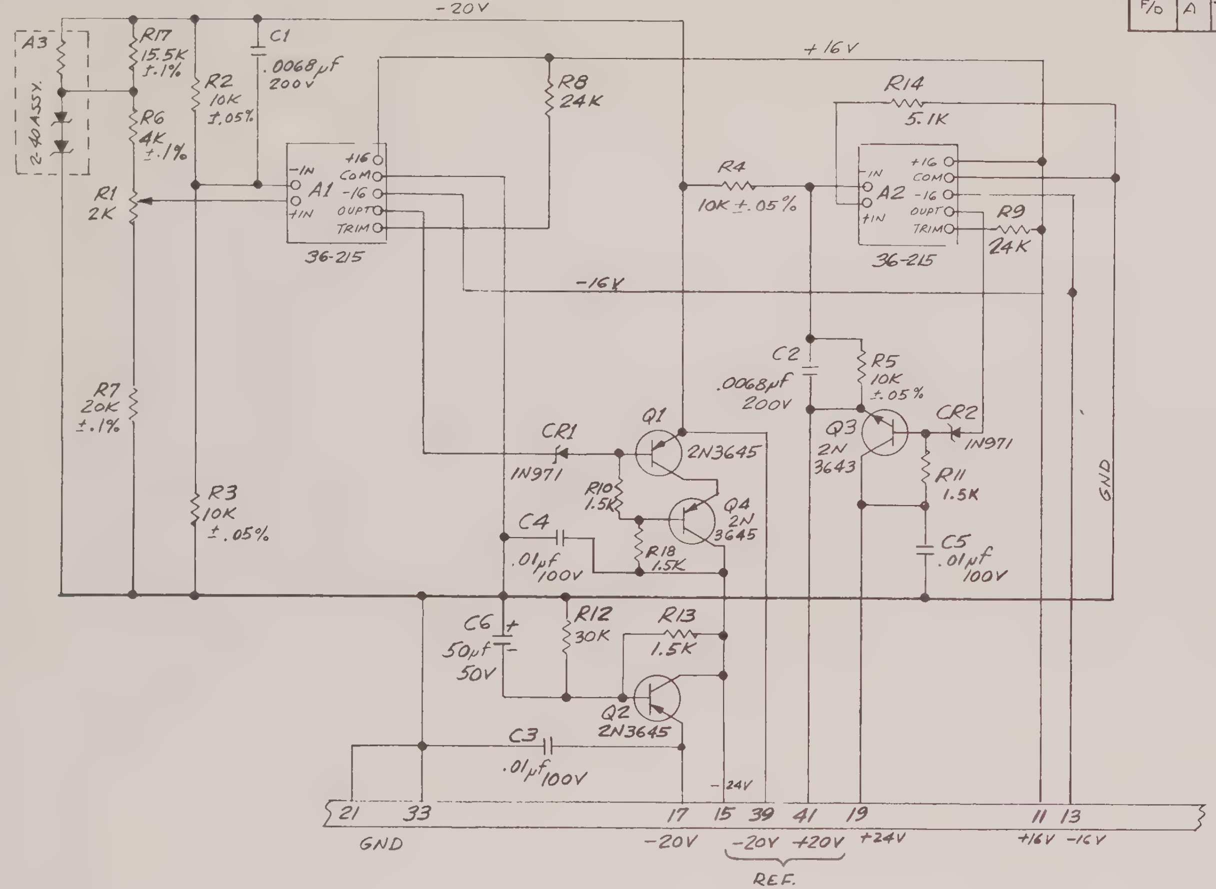
CONTR. NO.		
DRAWN	McKay	10-4-67
CHECK	Watkins	10-20-67
APPR	R. T. Warner	10-20-67
RELEASE DATE	10-23-67 pe	

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

SCHEMATIC
REFERENCE ASSEMBLY
X-2

SIZE C
CODE IDENT NO. 03626
37-272
SCALE —
WEIGHT
SHEET 2 OF 2

REVISIONS					
ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED
F/D	A	S/N.543 & ON	INCORP E.O. 1 of CH9 "O" & R11 WAS 3K 2-1-68 DH	2-1-68	


-20V
+16V
A3
2-40 ASSY.
R17
15.5K
±.1%
R6
4K
±.1%
R1
2K
R2
10K
±.05%
C1
.0068μf
200V
-IN
+IN
A1
+16
COM
-16
OUPT
TRIM
36-215
R8
24K
R4
10K ±.05%
R14
5.1K
-IN
+IN
A2
+16
COM
-16
OUPT
TRIM
36-215
R9
24K
-16V
R7
20K
±.1%
R3
10K
±.05%
C2
.0068μf
200V
R5
10K
±.05%
Q3
2N
3643
CR2
1N971
R11
1.5K
C5
.01μf
100V
GND
Q1
2N3645
CR1
1N971
R10
1.5K
Q4
2N
3645
R18
1.5K
C4
.01μf
100V
C6
50μf
50V
R12
30K
R13
1.5K
Q2
2N3645
C3
.01μf
100V
-24V
21
33
17
15
39
41
19
11
13
GND
-20V
-20V
+20V
REF.
+24V
+16V
-16V

37-272 SH2

3. REFERENCE DESIGNATIONS ARE ABBREVIATED; PREFIX WITH ASSEMBLY DESIGNATION SHOWN ON SHEET 2 OF FINAL ASSEMBLY

2. RESISTORS R2 THRU R7 & R17 ARE NLS PW2016

1. RESISTORS ARE 1/4 W, ±5%, CARBON.

NOTES: UNLESS OTHERWISE SPECIFIED

37-14	37-14	1	1
37-272	37-98	1	1
NEXT ASSY.	FINAL ASSY.	NEXT ASSY.	FINAL ASSY.
APPLICATION		QTY.	

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.

PARTS LIST

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ±.010
FRACTIONS ±1/32
ANGLES ±0° 30'
MATERIAL

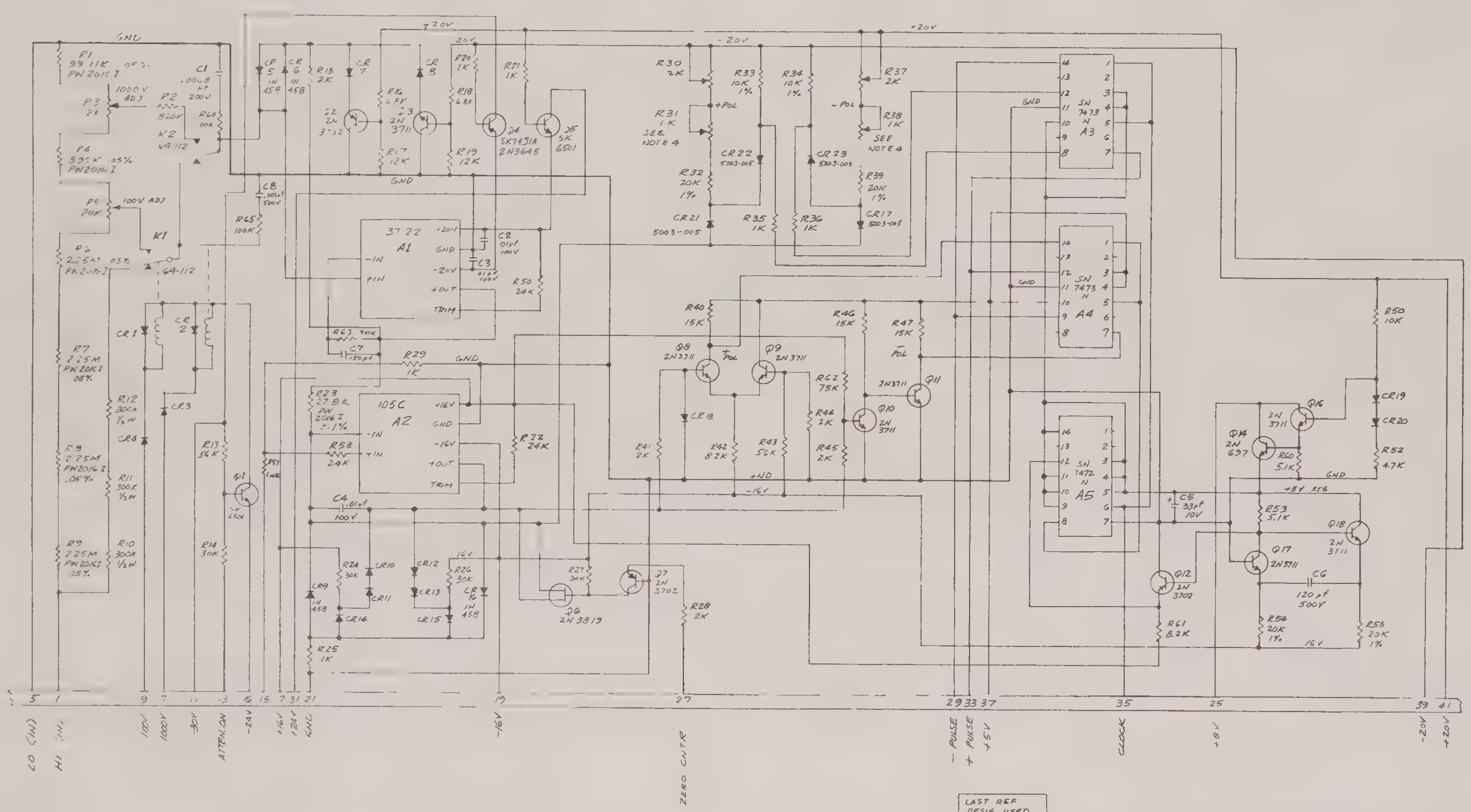
CONTR. NO.		
DRAWN	McKAY	10-14-67
CHECK	WATKINS	10-20-67
APPR	R. T. Warner	10-20-67
RELEASE DATE	10-23-67 pe	

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

SCHEMATIC
REFERENCE ASSEMBLY
X-2

SIZE C
CODE IDENT NO. 03626
37-272
SCALE —
WEIGHT
SHEET 2 of 2

REVISIONS					
ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED
	A	ALL	R6 was 7.25 M corrected A2 was 36-215	11-11-67	R T Warner


10V ADJ
GND
+20V
-20V
P1 99.11K .05% PW 2016 I
P2 510K
P3 2K
1000V ADJ
C1 .0068 µf 200V
R64 20K
K2 6A-112
P4 9.9K .05% PW2016 I
P5 20K
100V ADJ
K1 6A-112
P6 2.25M .05% PW20K I
R7 2.25M PW20K I .05%
CR1
CR2
CR3
CR4
R12 300K 1/2W
R8 2.25M PW2016 I .05%
R11 300K 1/2W
R9 2.25M PW20K I .05%
R10 300K 1/2W
R13 56K
Q1 SK 6501
R14 30K
R57 1MEG
R65 100K
C8 .002µf 500V
CR5 1N459
CR6 1N458
R15 2K
CR7
Q2 2N 3702
R16 6.8K
CR8
Q3 2N 3711
R17 12K
R20 1K
R18 6.8K
R19 12K
R21 1K
Q4 SK7431A 2N3645
Q5 SK 6501
37 22 A1
+20V GND -20V +OUT TRIM -IN +IN
C2 .01µf 100V
C3 .01µf 100V
R50 24K
R63 90K
C7 150pf
R29 1K
R23 27.8K PW 2016 I ±.1%
R58 24K
105C A2
+16V GND -16V +OUT TRIM -IN +IN
R22 24K
C4 .01µf 100V
R24 30K
CR9 1N458
CR10
CR11
CR14
CR12
CR13
CR15
R26 30K
CR16 1N458
R25 1K
R27 30K
Q6 2N3819
Q7 2N 3702
R28 2K
R30 2K
R31 1K SEE NOTE 4
R32 20K 1%
CR21 5003-005
R33 10K 1%
+POL
CR22 5003-005
R35 1K
R34 10K 1%
-POL
CR23 5003-005
R36 1K
R37 2K
R38 1K SEE NOTE 4
R39 20K 1%
CR17 5003-005
R40 15K
Q8 2N3711
+POL
Q9 2N3711
R41 2K
CR18
R42 8.2K
R43 56K
R62 75K
R44 2K
R45 2K
Q10 2N 3711
R46 15K
R47 15K
-POL
Q11 2N3711
+5V
-16V
SN 7473 N A3
SN 7473 N A4
SN 7472 N A5
C5 33µf 10V
Q12 2N 3702
R61 8.2K
R50 10K
CR19
CR20
R52 4.7K
Q14 2N 697
Q16 2N 3711
R60 5.1K
+5V REG
R53 5.1K
Q18 2N 3711
Q17 2N3711
C6 120pf 500V
R54 20K 1%
R55 20K 1%
16V
5 LO (IN)
1 HI (IN)
9 100V
7 1000V
11 30V
13 ATTEN ON
16 -24V
15 +16V
31 +24V
21 GND
19 -16V
27 ZERO CNTR
29 - PULSE
33 + PULSE
37 +5V
35 CLOCK
25 +8V
39 -20V
41 +20V

37-275 SH2

LAST REF DESIG. USED
CR 23
R 65
Q 18
C 8
A 5
K 2

4. FOR TEMPERATURE COMPENSATION ADJUSTMENT OF R31 & R38 SEE DOC#833
3. REFERENCE DESIGNATIONS ARE ABBREVIATED PREFIX WITH ASSEMBLY DESIGNATION SHOWN ON SHEET 2 OF FINAL ASSEMBLY
2. ALL DIODES ARE NLS 5003-002
1. ALL RESISTORS ARE 1/4 W 5%

NOTES UNLESS OTHERWISE SPECIFIED

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR CODE	CIRCUIT REF	ITEM NO

PARTS LIST

37-275	37-98	1	1
NEXT ASSY.	FINAL ASSY.	NEXT ASSY	FINAL ASSY
APPLICATION		QTY.	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010
FRACTIONS ± 1/32
ANGLES ± 0° 30'
MATERIAL

CONTR. NO.		
DRAWN	W. McKay	10-19-67
CHECK	Watkins	10-20-67
APPR	R Warner	10-20-67
RELEASE DATE	10.23.67	

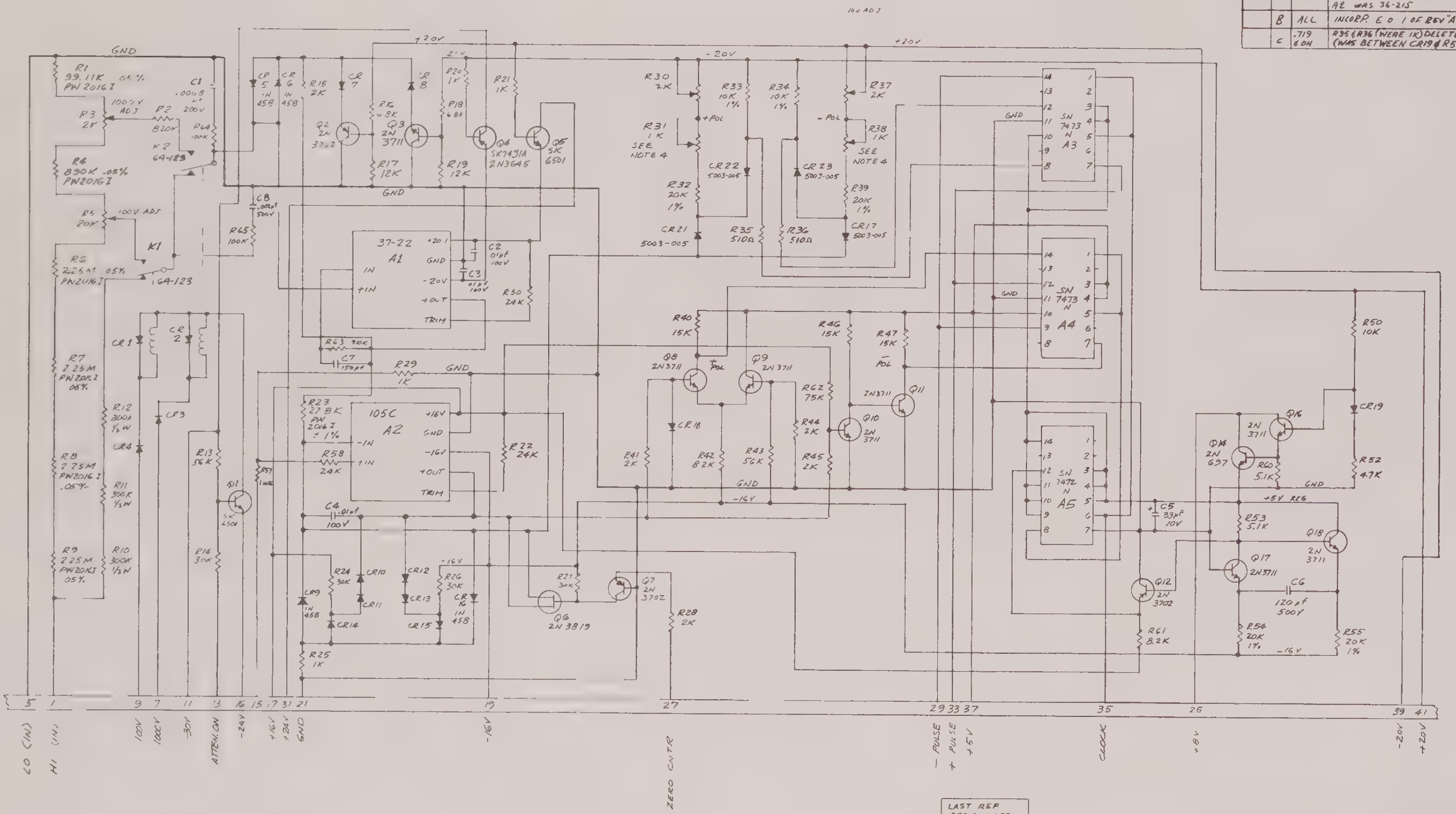
NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

SCHEMATIC, ATTENUATOR ASSY.

SERIES X-2

SIZE D
CODE IDENT NO. 03626
37-275
SCALE —
WEIGHT
SHEET 2

REVISIONS					
ZONE	LTR	EFFECT.	DESCRIPTION	DATE	APPROVED
	A	ALL	R6 was 7.25 M, corrected A2 was 36-215	11-1-67	R T Warner
	B	ALL	INCORP. E O 1 OF REV "A" 1-9-68 D.O.W.	1-9-68	R.T Warner
	C	.719 & ON	R35 & R36 (WERE 1K) DELETED CR20 (WAS BETWEEN CR19 & R52) JWW	3-12-68	R.T.W.


10V ADJ
GND
R1 99.11K .05% PW 2016 I
R3 2K
100.0V ADJ
P2 820K
R4 830K .05% PW 2016 I
R5 20K
100V ADJ
R6 22.5M .05% PW 2016 I
K1
64-123
C1 .0068 µf 200V
R64 100K
K2 64-123
CP 5 IN 459
CR 6 IN 458
R15 2K
CR 7
Q2 2N 3702
R16 6.8K
CR 8
Q3 2N 3711
P20 1K
P18 6.8K
R17 12K
R19 12K
R21 1K
Q4 SK7491A 2N3645
Q5 SK 6501
+20V
-20V
C8 .0022µf 500V
R65 100K
37-22 A1
IN
+IN
+20V
GND
-20V
+OUT
TRIM
C2 .01µf 100V
C3 .01µf 100V
R50 24K
CR1
CR2
CR3
CR4
R7 2.25M PW 2016 I .05%
R8 2.25M PW 2016 I .05%
R9 2.25M PW 2016 I .05%
R12 300K 1/2 W
R11 300K 1/2 W
R10 300K 1/2 W
R13 56K
R14 30K
Q1 SK 6501
R57 1 MEG
R63 910K
C7 150pf
R29 1K
R23 27.8K PW 2016 I ± 1%
R58 24K
105C A2
-IN
+IN
+16V
GND
-16V
+OUT
TRIM
R22 24K
C4 .01µf 100V
CR9 IN 458
R24 30K
CR10
CR11
CR14
CR12
CR13
CR15
R26 30K
CR 16 IN 458
R25 1K
R27 30K
Q6 2N 3819
Q7 2N 3702
R28 2K
R30 2K
R31 1K SEE NOTE 4
+POL
R33 10K 1%
R32 20K 1%
CR22 5003-005
CR21 5003-005
R35 510Ω
R34 10K 1%
R36 510Ω
CR23 5003-005
-POL
R37 2K
R38 1K SEE NOTE 4
R39 20K 1%
CR17 5003-005
R40 15K
Q8 2N3711
+POL
Q9 2N3711
CR18
R41 2K
R42 8.2K
R43 56K
R62 75K
R44 2K
R45 2K
R46 15K
R47 15K
-POL
Q10 2N 3711
Q11 2N3711
-16V
SN 7473 N A3
SN 7473 N A4
SN 7472 N A5
C5 33µf 10V
Q12 2N 3702
R61 8.2K
Q14 2N 697
Q16 2N 3711
R60 5.1K
+8V REG
R53 5.1K
Q17 2N3711
Q18 2N 3711
C6 120pf 500V
R54 20K 1%
R55 20K 1%
R50 10K
CR19
R52 4.7K
5
1
9
7
11
13
16
15
17
31
21
19
27
29
33
37
35
25
39
41
LO (IN)
HI (IN)
10V
100V
30V
ATTEN ON
-24V
+16V
+24V
GND
-16V
ZERO CNTR
- PULSE
+ PULSE
+5V
CLOCK
+8V
-20V
+20V

LAST REF DESIG USED
CR23
R65
Q18
C8
A5
K2

4. FOR TEMPERATURE COMPENSATION ADJUSTMENT OF R31 & R38 SEE DOC#833
3. REFERENCE DESIGNATIONS ARE ABBREVIATED PREFIX WITH ASSEMBLY DESIGNATION SHOWN ON SHEET 2 OF FINAL ASSEMBLY
2. ALL DIODES ARE NLS 5003-002
1. ALL RESISTORS ARE 1/4 W 5%

NOTES UNLESS OTHERWISE SPECIFIED

APPLICATION		QTY.	
NEXT ASSY.	FINAL ASSY.	NEXT ASSY	FINAL ASSY.
37-14	37-14	1	1
37-275	37-98	1	1

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.

PARTS LIST

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010
ANGLES ± 0° 30'
FRACTIONS ± 1/32

MATERIAL

CONTR. NO.		
DRAWN	W. McKay	10-19-67
CHECK	Watkins	10-20-67
APPR	R. Warner	10-20-67
RELEASE DATE	10.23.67	

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

SCHEMATIC, ATTENUATOR ASSY.

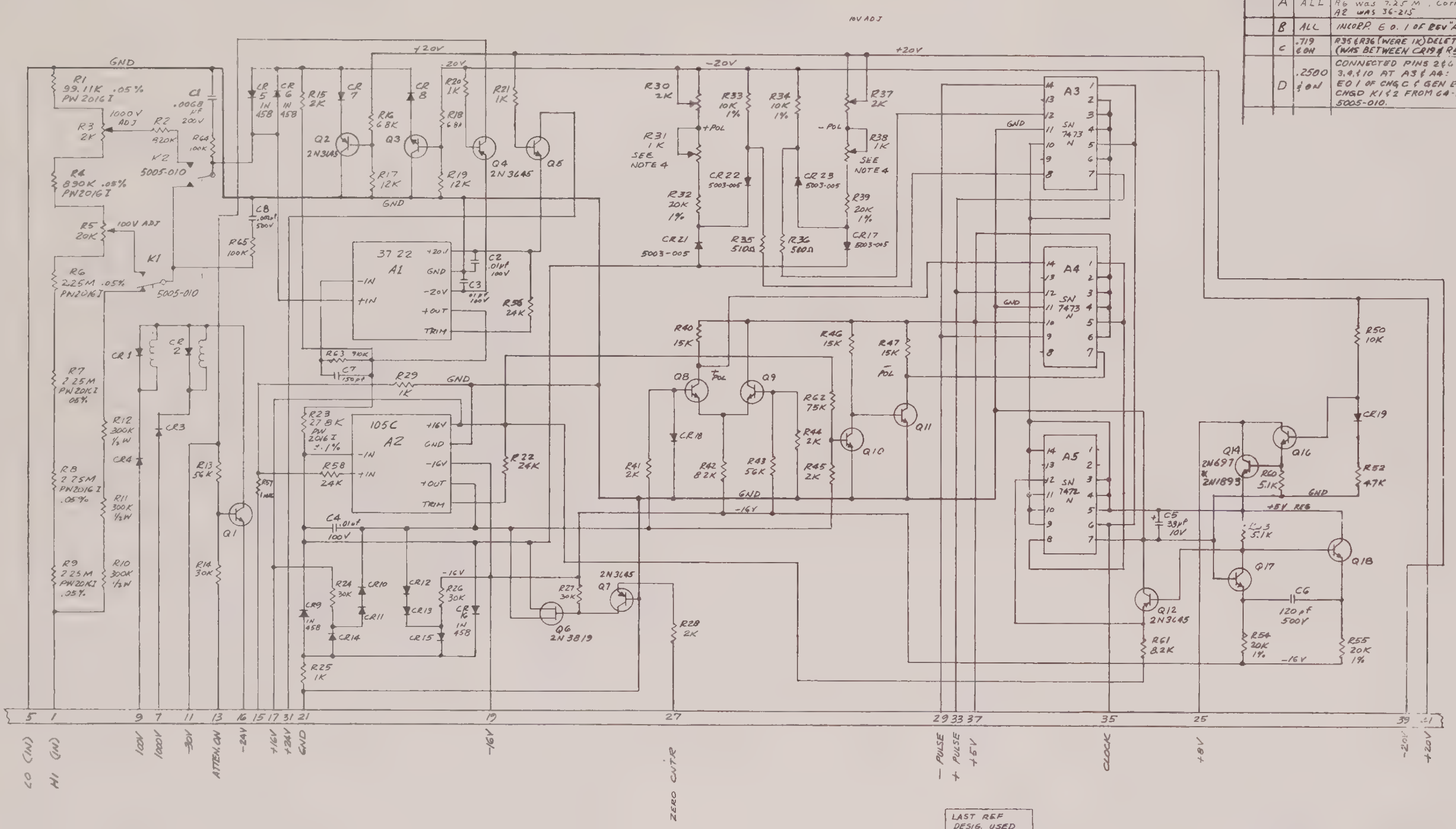
SERIES X-2

SIZE	CODE IDENT NO	
D	03626	37-275

SCALE — WEIGHT SHEET 2

37-275 SW2

REVISIONS					
ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED
	A	ALL	R6 was 7.25 M, corrected A2 was 36-215	11-11-67	R T Warner
	B	ALL	INCORP. E O. 1 OF REV "A" 1-9-68 R.O.W.	1-9-68	R.T.Warner
	C	.719 & ON	R35 & R36 (WERE 1K) DELETED CR20 (WAS BETWEEN CR19 & R52) JMW	3-12-68	R.T.W.
	D	.2500 & ON	CONNECTED PINS 2 & 6 TO PINS 3,4, & 10 AT A3 & A4: INCORP. EO 1 OF CHG C & GEN E.O.# 117: CHGD K1 & 2 FROM 64-123 TO 5005-010.	3-6-69	


NV ADJ
GND
+20V
-20V
R1 99.11K .05% PW 2016 I
R2 920K
R3 2K 1000V ADJ
C1 .0068 µf 200V
R64 100K
K2 5005-010
R4 890K .05% PW2016 I
R5 20K 100V ADJ
K1 5005-010
R6 2.25M .05% PW2016 I
R7 2.25M PW2016 I .05%
R8 2.75M PW2016 I .05%
R9 2.25M PW2016 I .05%
R10 300K 1/2W
R11 300K 1/2W
R12 300K 1/2W
CR1
CR2
CR3
CR4
R13 56K
R14 30K
R57 1 MEG
Q1
CR5 1N 458
CR6 1N 458
R15 2K
CR7
Q2 2N3645
R16 68K
R17 12K
Q3
CR8
R20 1K
R18 68K
R19 12K
Q4 2N 3645
R21 1K
Q5
C8 .001µf 500V
R65 100K
37 22 A1
+20V GND -20V +OUT TRIM -IN +IN
C2 .01µf 100V
C3 .01µf 100V
R56 24K
R63 90K
C7 150pf
R29 1K
105C A2
+16V GND -16V +OUT TRIM -IN +IN
R23 27.8K PW 2016 I .1%
R58 24K
C4 .01µf 100V
R22 24K
R24 30K
CR9 1N 458
CR10
CR11
CR14
CR12
CR13
CR15
R26 30K
CR16 1N 458
R25 1K
-16V
R27 30K
Q6 2N 3819
Q7 2N3645
R28 2K
R30 2K
R31 1K SEE NOTE 4
+POL
R32 20K 1%
CR21 5003-005
R33 10K 1%
CR22 5003-005
R35 510Ω
R34 10K 1%
-POL
CR23 5003-005
R36 510Ω
R37 2K
R38 1K SEE NOTE 4
R39 20K 1%
CR17 5003-005
R40 15K
Q8
+POL
Q9
CR18
R41 2K
R42 8.2K
R43 56K
GND
-16V
R62 75K
R44 2K
R45 2K
Q10
R46 15K
R47 15K
-POL
Q11
A3 SN 7473 N
A4 SN 7473 N
A5 SN 7472 N
1 2 3 4 5 6 7 8 9 10 11 12 13 14
GND
C5 39µf 10V
Q12 2N3645
R61 8.2K
Q14 2N697 * 2N1893
R60 5.1K
Q16
GND
+5V REG
R53 5.1K
Q17
C6 120pf 500V
R54 20K 1%
-16V
Q18
R55 20K 1%
R50 10K
CR19
R52 47K
5 1 9 7 11 13 16 15 17 31 21 19 27 29 33 37 35 25 39 41
LO (IN)
HI (IN)
100V
1000V
-30V
ATTEN.ON
-24V
+16V
+24V
GND
-16V
ZERO CNTR
- PULSE
+ PULSE
+5V
CLOCK
+8V
-20V
+20V
37-275 SH2

LAST REF DESIG. USED
CR 23
R65
Q18
C8
A5
K2

* ALTERNATE

5. TRANSISTORS ARE 2N3569
4. FOR TEMPERATURE COMPENSATION ADJUSTMENT OF R31 & R38 SEE DOC#833
3. REFERENCE DESIGNATIONS ARE ABBREVIATED. PREFIX WITH ASSEMBLY DESIGNATION SHOWN ON SHEET 2 OF FINAL ASSEMBLY
2. ALL DIODES ARE NLS 5003-002
1. ALL RESISTORS ARE 1/4 W 5%

NOTES UNLESS OTHERWISE SPECIFIED

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.

PARTS LIST

NEXT ASSY.	FINAL ASSY.	NEXT ASSY.	FINAL ASSY.
37-14	37-14	1	1
37-275	37-98	1	1
APPLICATION		QTY.	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010
FRACTIONS ± 1/32
ANGLES ± 0° 30'

MATERIAL

CONTR. NO.		
DRAWN	W. McKay	10-19-67
CHECK	Watkins	10-20-67
APPR		10-20-67
RELEASE DATE	10.23.67	

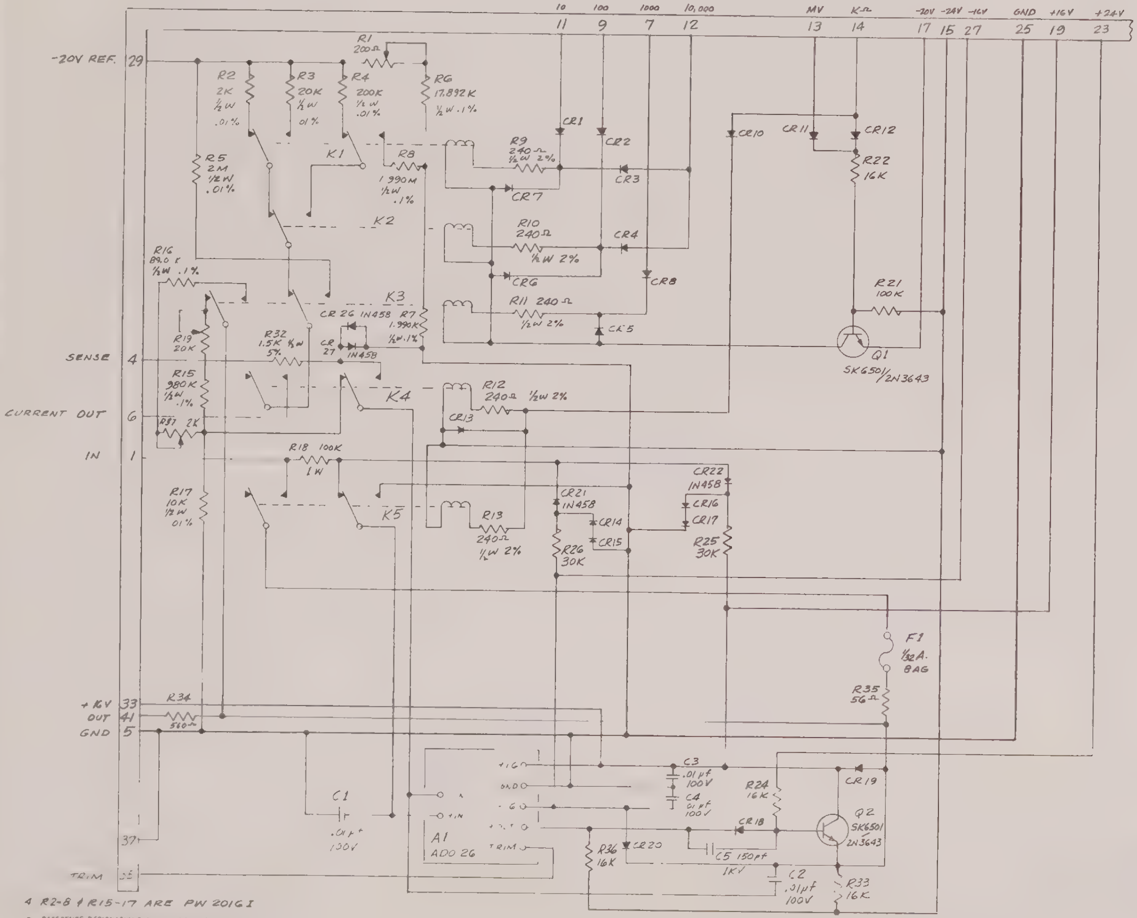
NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

SCHEMATIC, ATTENUATOR ASSY.

SERIES X-2

SIZE	CODE IDENT NO.	
D	03626	37-275
SCALE —	WEIGHT	SHEET 2

REVISIONS					
ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED
	A	S/N. 185 & ON	REMOVED CR28, ADDED R36 & R37 R16 WAS 90K .01% 12-1-67 R.O.W.	12-1-67	R.T. Wom



10
100
1000
10,000
MV
KΩ
-20V
-24V
-16V
GND
+16V
+24V
11
9
7
12
13
14
17
15
27
25
19
23
-20V REF.
29
SENSE
4
CURRENT OUT
6
IN
1
+KV
OUT
GND
33
41
5
37
TRIM
35
R1 200Ω
R2 2K ½W .01%
R3 20K ½W .01%
R4 200K ½W .01%
R5 2M ½W .01%
R6 17.892K ½W .1%
R7 1.990K ½W .1%
R8 1.990M ½W .1%
R9 240Ω ½W 2%
R10 240Ω ½W 2%
R11 240Ω ½W 2%
R12 240Ω ½W 2%
R13 240Ω ½W 2%
R15 980K ½W .1%
R16 89.0K ½W .1%
R17 10K ½W .01%
R18 100K 1W
R19 20K
R21 100K
R22 16K
R24 16K
R25 30K
R26 30K
R32 1.5K ¼W 5%
R33 16K
R34 560Ω
R35 56Ω
R36 16K
R37 2K
K1
K2
K3
K4
K5
CR1
CR2
CR3
CR4
CR5
CR6
CR7
CR8
CR10
CR11
CR12
CR13
CR14
CR15
CR16
CR17
CR18
CR19
CR20
CR21 1N458
CR22 1N458
CR26 1N458
CR27 1N458
Q1 SK650/2N3643
Q2 SK6501 2N3643
F1 1/32A. 8AG
C1 .01µf 100V
C2 .01µf 100V
C3 .01µf 100V
C4 .01µf 100V
C5 150pf 1KV
A1 ADO 26
+16
GND
-6
+V.IN
TRIM

4 R2-8 & R15-17 ARE PW 2016 I

3. REFERENCE DESIGNATIONS ARE ABBREVIATED. PREFIX WITH ASSEMBLY DESIGNATION SHOWN ON SHEET 2 OF FINAL ASSEMBLY

2. DIODES ARE 5003-002 (NLS)

1. RESISTORS ARE ¼W, 5%.

NOTES UNLESS OTHERWISE SPECIFIED

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO

PARTS LIST

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010
ANGLES ± 0° 30'
FRACTIONS ± 1/32

MATERIAL

CONTR NO		
DRAWN	W McKay	10-14-67
CHECK	Watkins	10-20-67
APPR	R. Weiner	10-20-67
RELEASE DATE	10-23-67	

37-278	37-98	1	1
NEXT ASSY.	FINAL ASSY.	NEXT ASSY.	FINAL ASSY.
APPLICATION		QTY.	

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

SCHEMATIC, PRE AMP & KΩ/DC CONVERTER

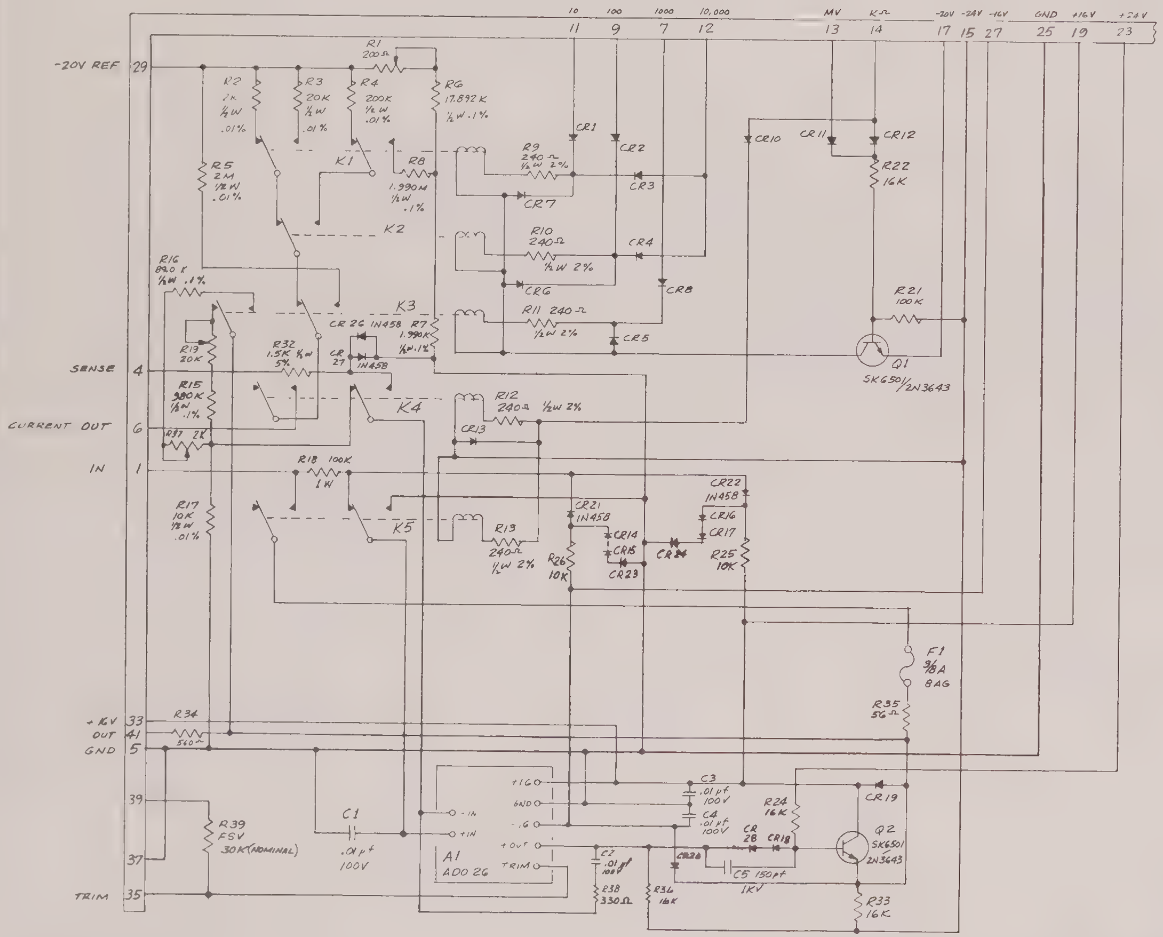
X-2 SERIES

SIZE D
CODE IDENT NO. 03626
37-278
SCALE —
WEIGHT
SHEET 2 OF 2

37-278 SH2

REVISIONS

ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED
	A	S/N. 185 & ON	REMOVED CR28, ADDED R36 & R37 R16 WAS 90K .01% 12-1-67 R.D.W.	12-1-67	R.T.Wo
	B	S/N. 329 & ON	ADDED CR23 & CR24. R25 & 26 (WERE 30K). JMW	12-15-67	R.T.W.
	C	ALL S/N. 455 & ON	INCORPORATED E.O. NO. 1 OF REV B. ADDED R38 & RELOCATED C2 DMB	2-15-68	R.T.W.
	D	S/N. 720 & ON	ADDED CR28 JMW	3-13-68	R.T.W.
	E	37-278 .4396 ON	ADDED R39 (TO PIN 35 & P39 CIRC.)	5-9-68	JMW.



10
100
1000
10,000
MV
KΩ
-20V
-24V
-16V
GND
+16V
+24V
11
9
7
12
13
14
17
15
27
25
19
23
-20V REF
29
SENSE
4
CURRENT OUT
6
IN
1
+16V
33
OUT
41
GND
5
39
37
TRIM
35
R1 200Ω
R2 2K ½W .01%
R3 20K ½W .01%
R4 200K ½W .01%
R6 17.892K ½W .1%
R5 2M ½W .01%
R8 1.990M ½W .1%
K1
K2
K3
K4
K5
R16 89.0K ½W .1%
R19 20K
R15 980K ½W .1%
R37 2K
R32 1.5K ¼W 5%
CR 26 1N458
CR 27 1N458
R7 1.990K ½W .1%
R17 10K ½W .01%
R18 100K 1W
R9 240Ω ½W 2%
R10 240Ω ½W 2%
R11 240Ω ½W 2%
R12 240Ω ½W 2%
R13 240Ω ½W 2%
CR1
CR2
CR3
CR4
CR5
CR6
CR7
CR8
CR10
CR11
CR12
CR13
R22 16K
R21 100K
Q1 SK6501/2N3643
CR21 1N458
CR14
CR15
CR23
CR24
CR22 1N458
CR16
CR17
R26 10K
R25 10K
F1 3/8A 8AG
R35 56Ω
R34 560
R39 FSV 30K (NOMINAL)
C1 .01µf 100V
A1 ADO 26
+16
GND
-16
+OUT
TRIM
-IN
+IN
C2 .01µf 100V
R38 330Ω
R36 16K
C3 .01µf 100V
C4 .01µf 100V
CR28
CR 28
CR18
C5 150pf 1KV
R24 16K
CR19
Q2 SK6501/2N3643
R33 16K

3. R2-8 & R15-17 ARE PW 2016 I
2 DIODES ARE 5003-002. (NLS)
1. RESISTORS ARE ¼W, 5%.
NOTES. UNLESS OTHERWISE SPECIFIED

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.

PARTS LIST

NEXT ASSY.	FINAL ASSY.	NEXT ASSY	FINAL ASSY
APPLICATION		QTY	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DEC MALS ± .010
ANGLES ± 0° 30'
FRACTIONS ± 1/32
MATERIAL

CONTR. NO.		
DRAWN	W. McKay	10-14-67
CHECK	Watkins	10-20-67
APPR	R. Wainer	10-20-67
RELEASE DATE	10-23-67	

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

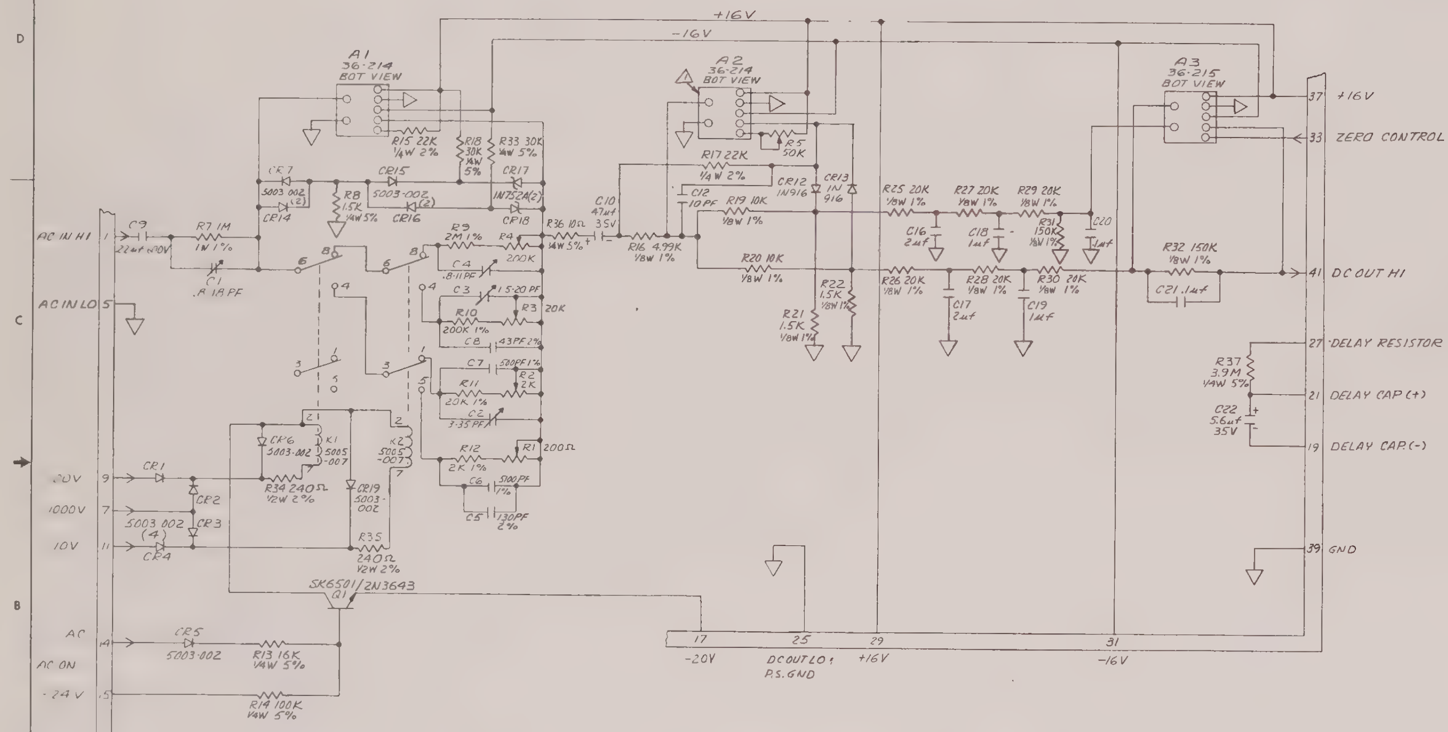
SCHEMATIC, PRE AMP &
KΩ/DC CONVERTER

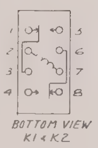
X-2 SERIES

SIZE D
CODE IDENT NO. 03626
37-278
SCALE --
WEIGHT
SHEET 2 OF 2

37-278 SH2

REVISIONS					
ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED
	A		R15 & 17 WERE 1/8 W. 11-15-67 R.D.W.	11-16-67	R.T.W.


A1
36-214
BOT VIEW
A2
36-214
BOT VIEW
A3
36-215
BOT VIEW
+16V
-16V
AC IN HI
AC IN LO
20V
1000V
10V
AC
AC ON
-24V
1
5
9
7
11
14
15
C9 22μf 400V
R7 1M 1W 1%
C1 .8 18 PF
CR7 5003 002 (2)
CR14
CR15 5003-002 (2)
CR16
R8 1.5K 1/4W 5%
R15 22K 1/4W 2%
R18 30K 1/4W 5%
R33 30K 1/4W 5%
CR17
1N752A(2)
CR18
R9 2M 1%
R4 200K
C4 .8-11PF
C3 1.5-20 PF
R3 20K
R10 200K 1%
C8 43PF 2%
C7 500PF 1%
R2 2K
R11 20K 1%
C2 3-35PF
R12 2K 1%
R1 200Ω
C6 5100PF 1%
C5 130PF 2%
R36 10Ω 1/4W 5%
C10 47μf 35V
R16 4.99K 1/8W 1%
C12 10PF
R17 22K 1/4W 2%
R19 10K 1/8W 1%
R20 10K 1/8W 1%
R5 50K
CR12 1N916
CR13 1N 916
R21 1.5K 1/8W 1%
R22 1.5K 1/8W 1%
R25 20K 1/8W 1%
R26 20K 1/8W 1%
R27 20K 1/8W 1%
R28 20K 1/8W 1%
R29 20K 1/8W 1%
R30 20K 1/8W 1%
R31 150K 1/8W 1%
C16 2μf
C17 2μf
C18 1μf
C19 1μf
C20 1μf
R32 150K 1/8W 1%
C21 .1μf
R37 3.9M 1/4W 5%
C22 5.6μf 35V
CR1
CR2
CR3
CR4
5003 002 (4)
CR6 5003-002
K1 5005 -007
K2 5005 -007
R34 240Ω 1/2W 2%
CR19 5003-002
R35 240Ω 1/2W 2%
SK6501/2N3643 Q1
CR5 5003-002
R13 16K 1/4W 5%
R14 100K 1/4W 5%
37 +16V
33 ZERO CONTROL
41 DC OUT HI
27 DELAY RESISTOR
21 DELAY CAP (+)
19 DELAY CAP (-)
39 GND
17 -20V
25 DC OUT LO; P.S. GND
29 +16V
31 -16V



BOTTOM VIEW
K1 & K2

CALIBRATION INSTRUCTIONS			
PROC NO.	RANGE	INPUT	ADJUST
1	1000V	0	REAR PANEL ADJUST (AC OFF SET)
2	1000V	500V - 200 HZ	K1
3	1000V	500V - 10K HZ	C1
4	100V	100V - 200 HZ	R2
5	100V	100V - 10K HZ	C2
6	10V	10V - 200 HZ	R3
7	10V	10V - 10K HZ	C3
8	1V	1V - 200 HZ	R4
9	1V	1V - 10K HZ	C4

⚠1 THIS POINT SHOULD MEASURE 0v ± 1MV.
IF NOT, ADJUST R5.

NOTES UNLESS OTHERWISE [illegible]D

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.

PARTS LIST

37-98	37 98	1	1
NEXT ASSY.	FINAL ASSY.	NEXT ASSY	FINAL ASSY
APPLICATION		QTY	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010
FRACTIONS ± 1/32
ANGLES ± 0° 30'
MATERIAL

CONTR. NO.
DRAWN Wanechaw 10-21-67
CHECK Watkins 10-23-67
APPR R T Warner 10-23-67
RELEASE DATE

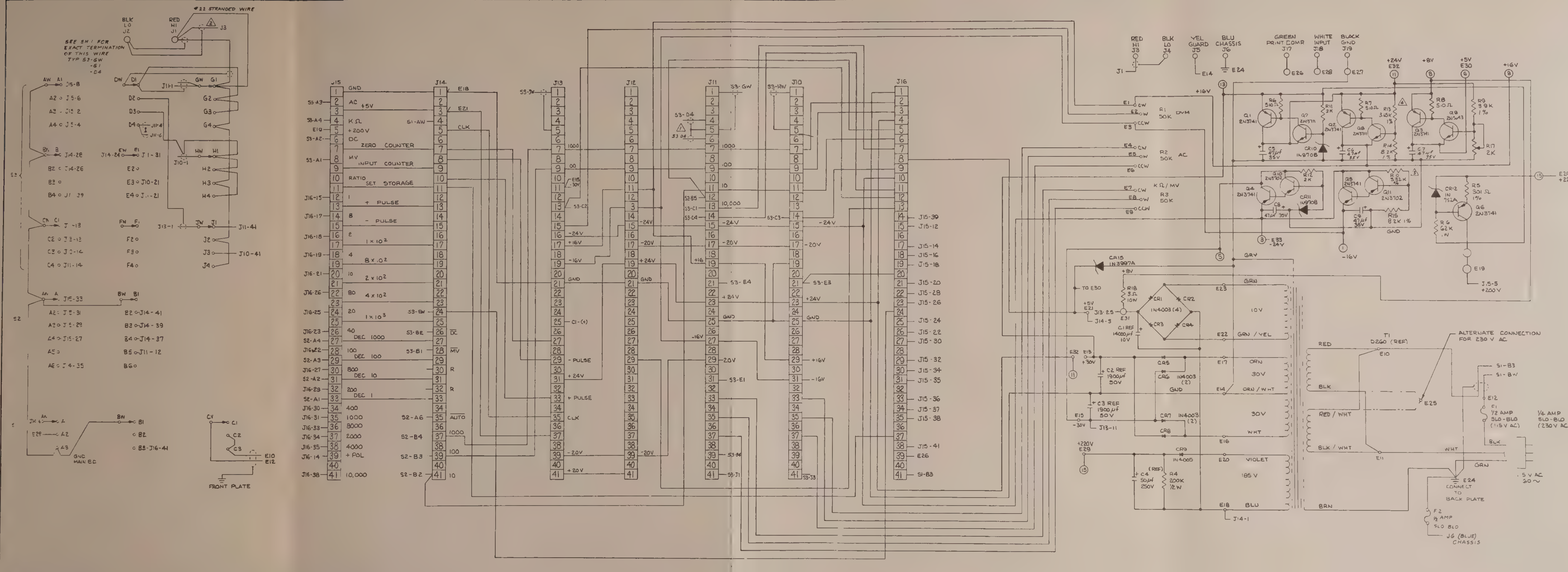
NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

ASSY, AC/DC CONVERTER
SCHEMATIC
SERIES X-2

SIZE D
CODE IDENT NO 03626
37-281
SCALE —
WEIGHT —
SHEET 2 of 2

37-281 SH2

REVISIONS					
SYM	ZONE	EFFECT.	DESCRIPTION	DATE	APPROVED
F	O/A	SN.1213 & ON	REVISED / REDRAWN INCORP. E.O. 1 OF CHG "E"	9-10-68	R.T.W.



#22 STRANDED WIRE
SEE SH. 1 FOR EXACT TERMINATION OF THIS WIRE
BLK LO J2
RED HI J1 J3
J15
J14
J13
J12
J11
J10
J16
GND
AC
+5V
KΩ
+200V
DC
ZERO COUNTER
MV
INPUT COUNTER
RATIO
SET STORAGE
+ PULSE
- PULSE
DEC 1000
DEC 100
DEC 10
DEC 1
+ POL
AUTO
CLK
-24V
+16V
-16V
-20V
+24V
FRONT PLATE
RED HI J3
BLK LO J4
YEL GUARD J5
BLU CHASSIS J6
GREEN PRINT COMD J17
WHITE INPUT J18
BLACK GND J19
R1 50K DVM
R2 50K AC
R3 50K KΩ/MV
CR15 1N3997A
1N4003 (4)
T1 D260 (REF)
ALTERNATE CONNECTION FOR 230 V AC
F1 1/2 AMP SLO-BLO (115 V AC)
1/4 AMP SLO-BLO (230 V AC)
F2 1/8 AMP SLO BLO
CONNECT TO BACK PLATE
J6 (BLUE) CHASSIS
5 V AC 30 ~
RED
BLK
RED / WHT
BLK / WHT
GRN
GRN / YEL
ORN
ORN / WHT
WHT
VIOLET
BLU
BRN
GRY
10V
30V
185 V
+230 V E28
C4 50μf 250V
R4 200K 1/2W

37-298 SH 2

4. ADD RESISTOR FSV NCM 15K ½W 5% IN PARALLEL WITH R13 TO PROVIDE +17.5V MIN +18V MAX AT TERMINAL 9.

3. ADD RESISTOR FSV NCM 15K ½W 5% IN PARALLEL WITH R10 TO PROVIDE -17V MIN -18V MAX AT TERMINAL 1.

2. RG 58 A/U

1. MCHAAK #167. CABLE

QTY REQD	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.	NEXT ASSY	FINAL ASSY.	NEXT ASSY	FINAL ASSY
						37-14	37-14	1	1
						37-15	37-5	1	
						37-16	37-6	1	1
						37-98	37-98	1	1
PARTS LIST						APPLICATION		QTY	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010
FRACTIONS ± 1/32
ANGLES ± 0° 30'
SURFACE ROUGHNESS PER MIL-STD-10 ✓
DO NOT SCALE THIS DRAWING
RELEASE DATE 11-10-67 PC

DRAWN	WEINBERG	10-23-67
CHECK	WATKINS	11-9-67
APPR	R.T. WARNER	11-10-67

MATERIAL

FINISH

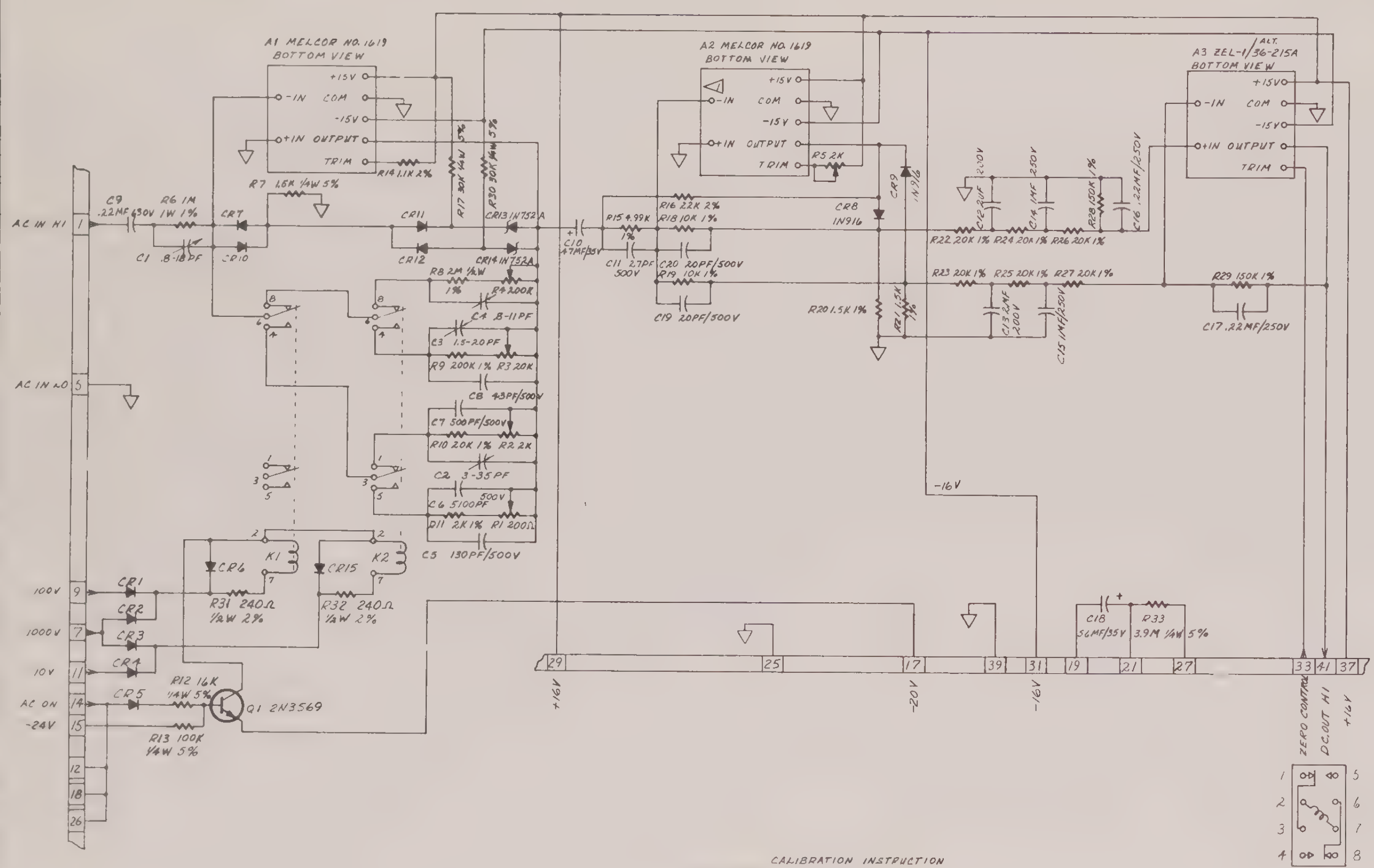
NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

SCHEMATIC -
MAIN BOARD AND POWER SUPPLY
SERIES X-2 W/PRINT

CODE IDENT NO. 03626
SIZE R
37 - 298
SCALE
WEIGHT
SHEET 2 OF 2

REVISIONS

ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED


A1 MELCOR NO. 1619
BOTTOM VIEW
+15V
-IN
COM
-15V
+IN
OUTPUT
TRIM
R14 1.1K 2%
R7 1.5K 1/4W 5%
C9 .22MF 630V
R6 1M 1W 1%
C1 .8-18PF
CR7
CR10
CR11
CR12
R17 30K 1/4W 5%
R30 30K 1/4W 5%
CR13 1N752A
CR14 1N752A
R8 2M 1/2W 1%
R4 200K
C4 .8-11PF
C3 1.5-20PF
R9 200K 1% R3 20K
C8 43PF/500V
C7 500PF/500V
R10 20K 1% R2 2K
C2 3-35PF
C6 5100PF 500V
R11 2K 1% R1 200Ω
C5 130PF/500V
K1
K2
CR6
CR15
R31 240Ω 1/2W 2%
R32 240Ω 1/2W 2%
CR1
CR2
CR3
CR4
CR5
R12 16K 1/4W 5%
R13 100K 1/4W 5%
Q1 2N3569
AC IN HI
AC IN LO
100V
1000V
10V
AC ON
-24V
1
5
9
7
11
14
15
12
18
26
A2 MELCOR NO. 1619
BOTTOM VIEW
R5 2K
C10 47MF/35V
R15 4.99K 1%
C11 2.7PF 500V
R16 22K 2%
R18 10K 1%
C20 20PF/500V
R19 10K 1%
C19 20PF/500V
CR8 1N916
CR9 1N916
R20 1.5K 1%
R21 1.5K 1%
C12 2UF 200V
C14 1MF 250V
R28 150K 1%
C16 .22MF/250V
R22 20K 1%
R24 20K 1%
R26 20K 1%
R23 20K 1%
R25 20K 1%
R27 20K 1%
C13 2MF 200V
C15 1MF/250V
A3 ZEL-1/36-215A ALT.
BOTTOM VIEW
R29 150K 1%
C17 .22MF/250V
C18 56MF/35V
R33 3.9M 1/4W 5%
-16V
29
25
17
39
31
19
21
27
33
41
37
+16V
-20V
-16V
ZERO CONTROL
DC OUT HI
+16V
BOTTOM VIEW
K1 & K2

CALIBRATION INSTRUCTION

PROCEDURE NO.	RANGE	INPUT	ADJUST
1	1000V	0	REAR PANEL CONTROL (AC OFFSET)
2	1000V	500V - 200HZ	R1
.	1000V	500V - 80KHZ	C1
4	100V	100V - 200HZ	R2
5	100V	100V - 80KHZ	C2
6	10V	10V - 200HZ	R3
7	10V	10V - 80KHZ	C3
8	1V	1V - 200HZ	R4
9	1V	1V - 80KHZ	C4

5. ALL RELAYS ARE 5005-007
4 ALL RESISTORS ARE 1/8W
3 ALL DIODES ARE NLS 5003-002
2. AFTER CALIBRATION, SPOT CHECK AT VARIOUS FREQUENCIES THROUGHOUT BAND WIDTH OF CONVERTER.

◁1 THIS POINT SHOULD MEASURE 0V ± 1MV. ADJUST R5 FOR CORRECTION.
NOTES UNLESS OTHERWISE SPECIFIED

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR CODE	CIRCUIT REF	ITEM NO.

PARTS LIST

NEXT ASSY.	FINAL ASSY.	NEXT ASSY.	FINAL ASSY
APPLICATION		QTY	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010
FRACTIONS ± 1/32
ANGLES ± 0° 30'
MATERIAL

CONTR. NO.
DRAWN 2-19-69
CHECK 3-5-69
APPR K. Warner 3-5-69
RELEASE DATE 3 5 69 ML

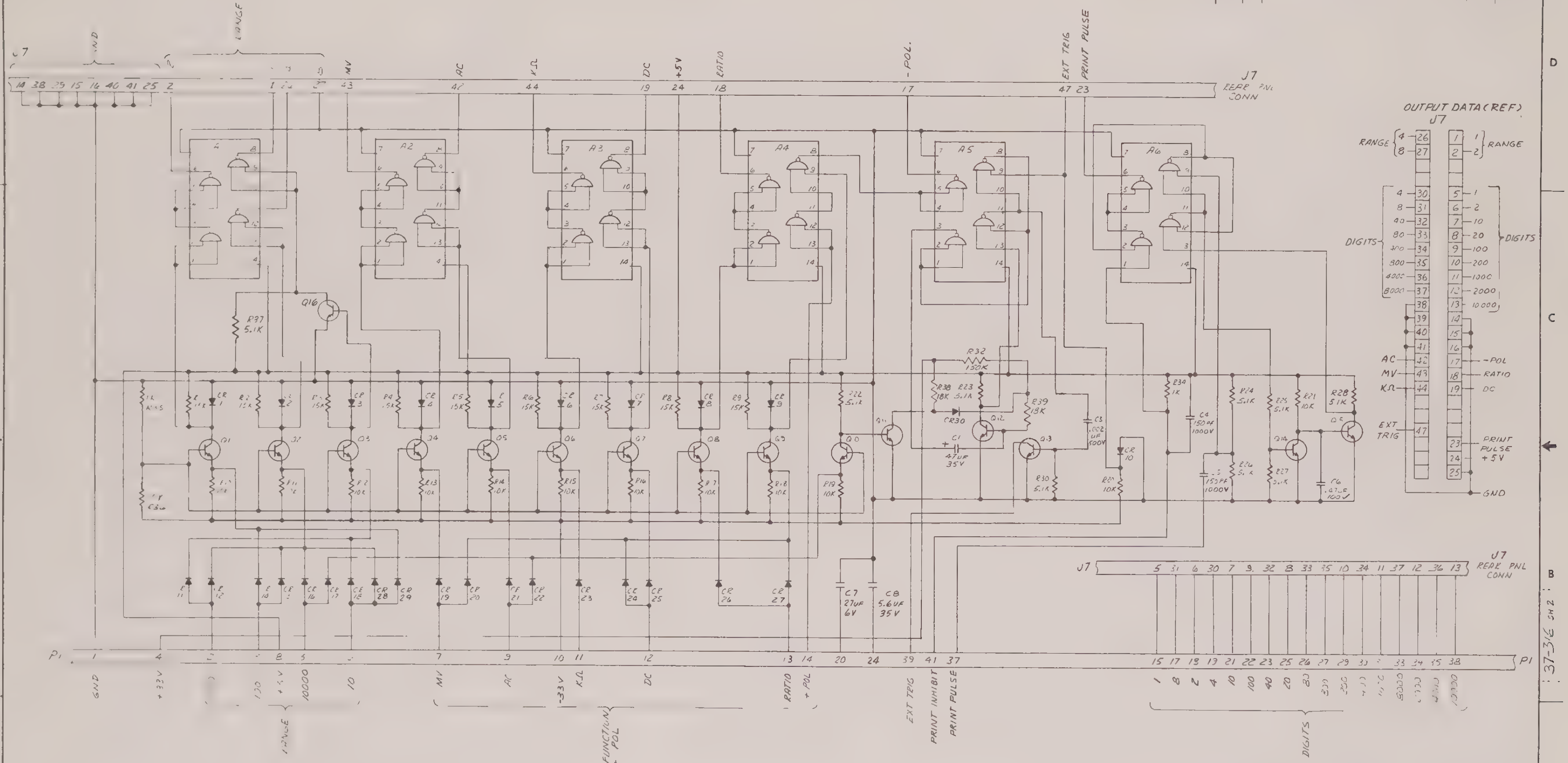
NLS NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

SCHEMATIC
100KHZ AC/DC CONVERTER
SERIES X-2

SIZE D
CODE IDENT NO. 03626
37-315
SCALE
WEIGHT
SHEET 2 OF 3

37-315 #2

REVISIONS					
ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED


J7
14 38 39 15 16 40 41 25 2
1 2 3
43 MV
41 AC
44 KΩ
19 DC
24 +5V
18 RATIO
17 -POL.
47 EXT TRIG
23 PRINT PULSE
J7 REAR PNL CONN
RANGE
GND
A2
A3
A4
A5
A6
Q16
R37 5.1K
Q1
Q2
Q3
Q4
Q5
Q6
Q7
Q8
Q9
Q10
Q11
Q12
Q13
Q14
Q15
R32 150K
R38 18K
R23 5.1K
R39 18K
CR30
C1 47uF 35V
C3 .002 uF 500V
R30 5.1K
R20 10K
CR 10
R34 1K
C4 150PF 1000V
R24 5.1K
R25 5.1K
R21 10K
R28 5.1K
R26 5.1K
R27 5.1K
C5 150PF 1000V
C6 .47uF 100V
R22 5.1K
R19 10K
C7 27uF 6V
C8 5.6uF 35V
OUTPUT DATA (REF)
J7
RANGE
4 26
8 27
1 1
2 2
DIGITS
4 30
8 31
40 32
80 33
400 34
800 35
4000 36
8000 37
38
39
40
41
AC 42
MV 43
KΩ 44
EXT TRIG 47
5 1
6 2
7 10
8 20
9 100
10 200
11 1000
12 2000
13 10000
14
15
16
17 -POL
18 RATIO
19 DC
23 PRINT PULSE
24 +5V
25
GND
J7
5 31 6 30 7 9 32 8 33 35 10 34 11 37 12 36 13
J7 REAR PNL CONN
P1
1 GND
4 +33V
8 +5V
5 10000
7 MV
9 AC
10 -33V
11 KΩ
12 DC
13 RATIO
14 +POL
20
24
39 EXT TRIG
41 PRINT INHIBIT
37 PRINT PULSE
15 17 18 19 21 22 23 25 26 27 29 30 33 34 35 38
1 8 2 4 10 100 40 20 80 200 800 1000 8000 2000 4000 10000
RANGE
FUNCTION & POL
DIGITS
P1

RANGE TRUTH TABLE +5V=TRUE

		8	4	2	1	DISCRETE NUMBER
QXXXX	1		1			4
OXXXX	10			1	1	3
OXX.XX	100			1		2
OXXX.X	1000				1	1
OXXXX	10000					0

4. ALL DIP SN7400N
3. ALL RESISTORS ¼W, 5%
2. ALL TRANSISTORS 2N3711
1. ALL DIODES NLS 5003-002

NOTES. UNLESS OTHERWISE SPECIFIED

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR CODE	CIRCUIT REF	ITEM NO.

PARTS LIST

37-98	37-98	1	1
37-16	37-16	1	1
37-15	37-15	1	1
37-14	37-14	1	1
NEXT ASSY.	FINAL ASSY.	NEXT ASSY.	FINAL ASSY.
APPLICATION		QTY.	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010
ANGLES ± 0° 30'
FRACTIONS ± 1/32
MATERIAL

CONTR. NO.
DRAWN LAYTON 12-1-67
CHECK 12-1-67
APPR R. T. 12-1-67
RELEASE DATE 12-1-67 pe

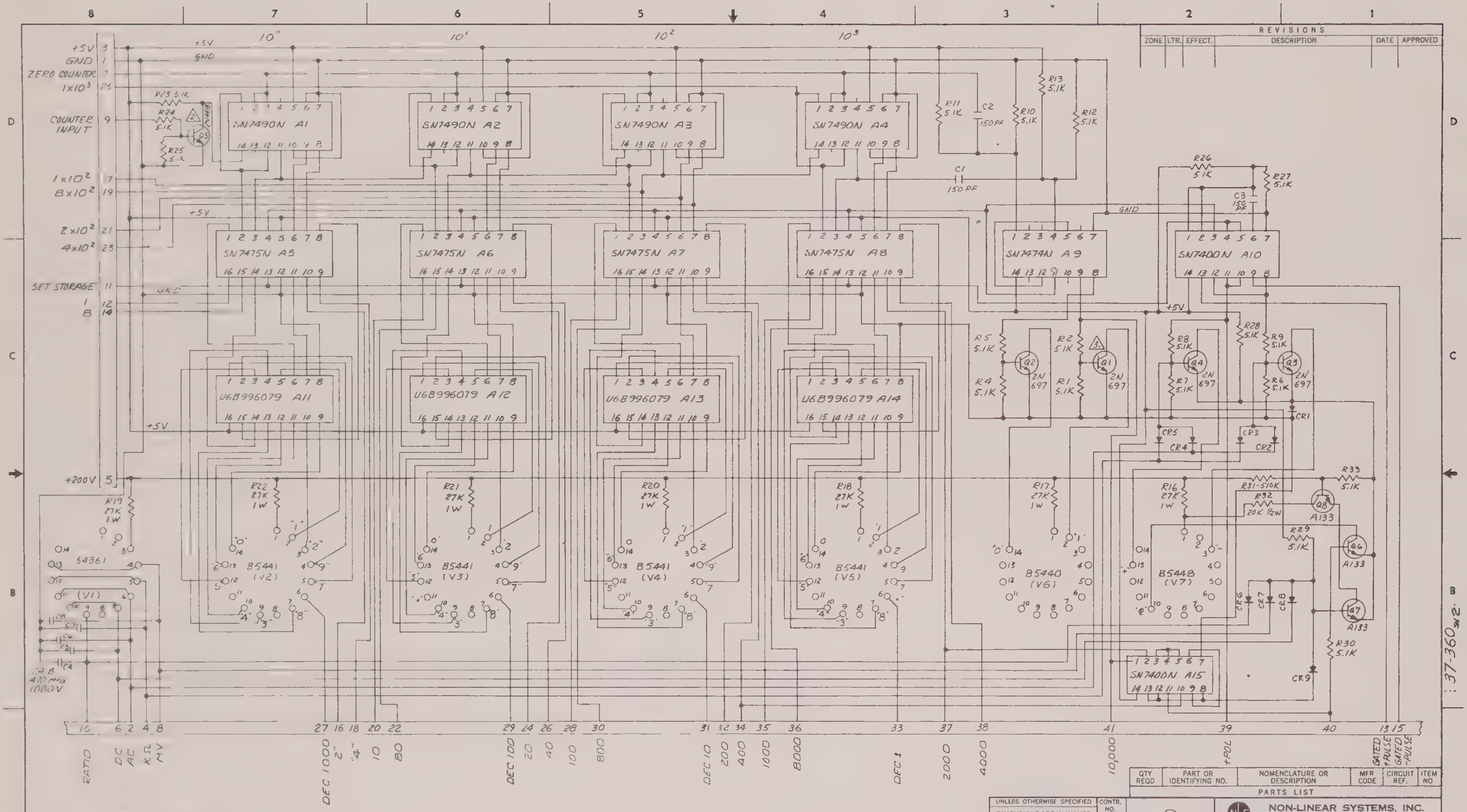
NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

ASSY, PRINT BOARD
SCHEMATIC

SERIES X-2

SIZE D
CODE IDENT NO. 03626
37-316
SCALE
WEIGHT
SHEET 2 OF 3

37-316 SH 2


REVISIONS
ZONE
LTR.
EFFECT.
DESCRIPTION
DATE
APPROVED
10⁰
10¹
10²
10³
+5V 3
GND 1
ZERO COUNTER 7
1x10³ 25
COUNTER INPUT 9
1x10² 17
8x10² 19
2x10² 21
4x10² 23
SET STORAGE 11
1 12
8 14
+200V 5
+5V
GND
R23 5.1K
R24 5.1K
R25 5.1K
Q5
2N1418
SN7490N A1
SN7490N A2
SN7490N A3
SN7490N A4
SN7475N A5
SN7475N A6
SN7475N A7
SN7475N A8
SN7474N A9
SN7400N A10
U6B996079 A11
U6B996079 A12
U6B996079 A13
U6B996079 A14
SN7400N A15
R11 5.1K
C2 150PF
R10 5.1K
R13 5.1K
R12 5.1K
C1 150PF
R26 5.1K
R27 5.1K
C3 150 PF
R5 5.1K
R4 5.1K
Q2 2N697
R2 5.1K
R1 5.1K
Q1 2N697
R8 5.1K
R7 5.1K
Q4 2N697
R28 5.1K
R9 5.1K
R6 5.1K
Q3 2N697
CR1
CR2
CR3
CR4
CR5
CR6
CR7
CR8
CR9
R19 27K 1W
R22 27K 1W
R21 27K 1W
R20 27K 1W
R18 27K 1W
R17 27K 1W
R16 27K 1W
R31 510K
R32 20K ½W
R33 5.1K
R29 5.1K
R30 5.1K
Q8 A133
Q6 A133
Q7 A133
54361 (V1)
B5441 (V2)
B5441 (V3)
B5441 (V4)
B5441 (V5)
B5440 (V6)
B5448 (V7)
C4
C5
C6
.24 B 470 MMFD 1000V
10 6 2 4 8 27 16 18 20 22 29 24 26 28 30 31 32 34 35 36 33 37 38 41 39 40 13 15
RATIO
DC
AC
KΩ
MV
DEC 1000
"2"
"4"
10
80
DEC 100
20
40
100
800
DEC 10
200
400
1000
8000
DEC 1
2000
4000
10,000
+POL
GATED +PULSE
GATED -PULSE
37-360 SH 2

7. REF: R10 STORAGE & COUNTER 37-359.
6. REF.: R10 DRIVER ASSY 37-356.
5 ALL RESISTORS ARE ¼W 5%.
4. ALL DIODES ARE NLS TYPE 5003-002.
3. Q1-Q4 ALTERNATE: A133 (AMPEREX).
2. Q5 ALTERNATE: 2N2368 (T.I.).
1. [illegible]

NOTES UNLESS OTHERWISE SPECIFIED

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR CODE	CIRCUIT REF.	ITEM NO

PARTS LIST

37-14	37-14	1	1
NEXT ASSY.	FINAL ASSY.	NEXT ASSY.	FINAL ASSY
APPLICATION		QTY.	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010
FRACTIONS ± 1/32
ANGLES ± 0° 30'

MATERIAL

CONTR. NO.
DRAWN 1-15-68
CHECK 1-16-68
APPR 1-16-68
RELEASE DATE 1-16-68

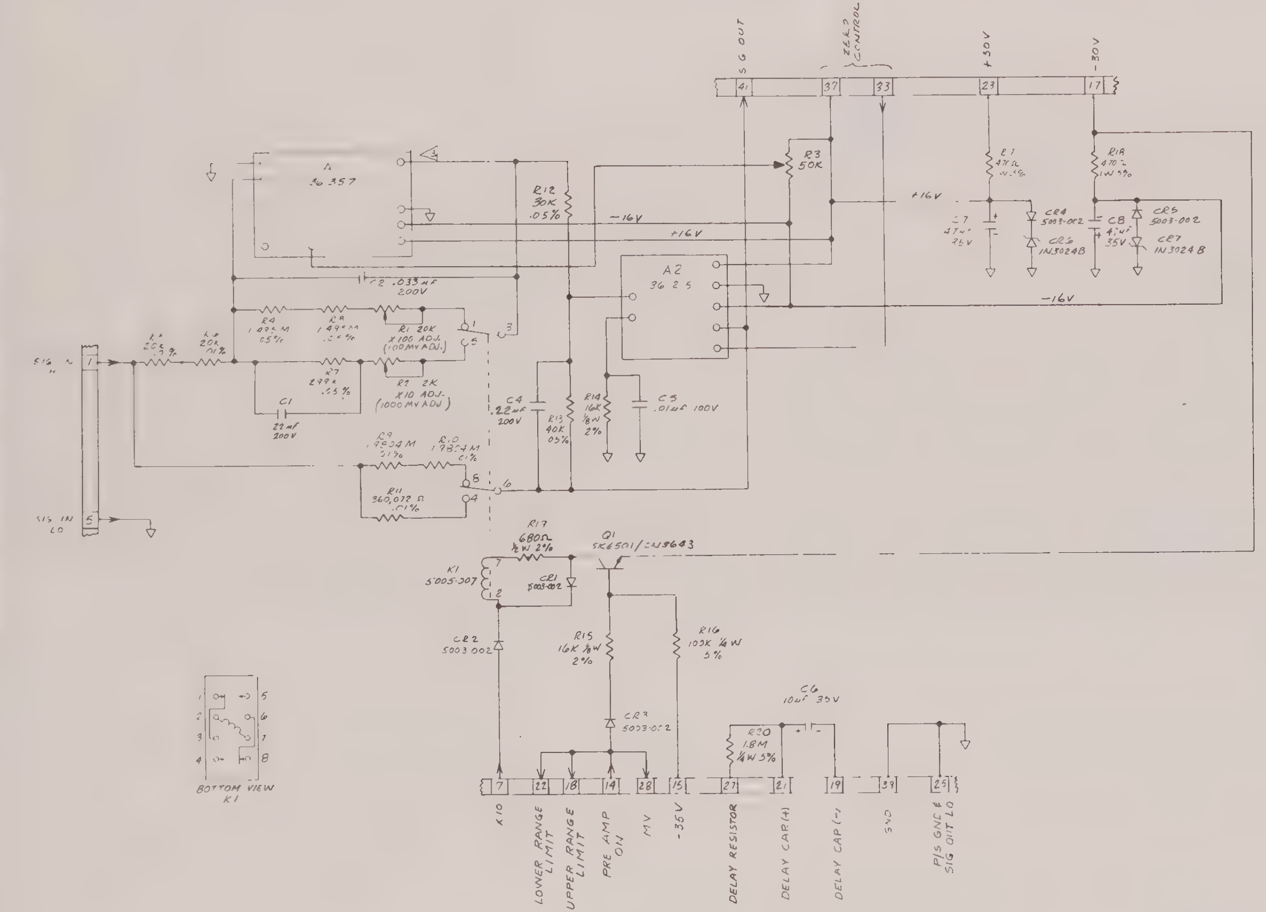
NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

ASSY, DECADE SCHEMATIC
SERIES X2

SIZE D
CODE IDENT NO. 03626
37-360
SCALE —
WEIGHT —
SHEET 2 of 2

REVISIONS

ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED


SIG IN HI
1
5
SIG IN LO
R5 20K .01%
R6 20K .01%
R4 1.495 M .05%
R8 1.495 M .05%
R1 20K X100 ADJ. (100MV ADJ.)
R7 299K .05%
R2 2K X10 ADJ. (1000MV ADJ)
C1 22nf 200V
C2 .033nf 200V
R9 1.9504 M .01%
R10 1.9804 M .01%
R11 360,072 Ω .01%
1
3
5
8
6
4
A 36 357
R12 30K .05%
-16V
+16V
A2 36 25
C4 .22nf 200V
R13 40K .05%
R14 16K 1/8W 2%
C5 .01nf 100V
R3 50K
41
37
33
23
17
S G OUT
ZERO CONTROL
+30V
-30V
R1 470Ω W 5%
R18 470Ω 1W 5%
+16V
C7 47nf 35V
CR4 5003-002
CR6 1N3024B
C8 47nf 35V
CR5 5003-002
CR7 1N3024 B
-16V
R17 680Ω 1/2W 2%
Q1 SK6501/2N3643
K1 5005-307
7
2
CR1 5003-002
CR2 5003 002
R15 16K 1/8W 2%
R16 100K 1/4W 5%
CR3 5003-002
C6 10uf 35V
R20 1.8M 1/4W 5%
7
22
18
14
28
15
27
21
19
39
25
X10
LOWER RANGE LIMIT
UPPER RANGE LIMIT
PRE AMP ON
MV
-35V
DELAY RESISTOR
DELAY CAP (+)
DELAY CAP (-)
GND
P/S GND & SIG OUT LO
1 2 3 4 5 6 7 8
BOTTOM VIEW K1

WITH INPUT LEADS SHORTED TOGETHER, ADJUST R3 UNTIL THIS POINT MEASURES 0 VDC ±500uV ON BOTH RANGES. ALLOW 15 MIN. WARM UP TIME.

1. R4 THRU R13 ARE NLS W.W.P PW2016 RESISTORS.

NOTES:

QTY REQD	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.

PARTS LIST

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ±.010
FRACTIONS ±1/32
ANGLES ±0° 30'

CONTR. NO.		
DRAWN	Dencher	4-26-67
CHECK	SOULE	5-2-67
APPR	Hoffheimer	5-2-67
RELEASE DATE	5-5-67	

MATERIAL
SEE SH-1

NEXT ASSY.	FINAL ASSY.	NEXT ASSY	FINAL ASSY
APPLICATION		QTY	

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

SCHEMATIC -
MV CONVERTER ASSY
SERIES X1

SIZE D
CODE IDENT NO. 03626
36-658
SCALE
WEIGHT
SHEET 2

36-658

warranty

It is the continuous effort of Non-Linear Systems, Inc., to design and manufacture its products in such fashion as to at all times achieve the maximum customer satisfaction. Non-Linear Systems, Inc., issues this warranty in full recognition of its continuing obligation to its customers and its desire to always retain their respect and good will.

Non-Linear Systems, Inc., shall correct, either by repair or replacement, defects in material or workmanship in Non-Linear manufactured units or components where such defect develops within one year after delivery of the equipment to the original customer. In the instance of a defect of Sub-assemblies, Assemblies or Instruments manufactured by others than Non-Linear, every effort will be made to assist the customer in obtaining relief from the original manufacturer.

Any instrument claimed to be defective must be returned to Non-Linear Systems, Inc., Del Mar, California, transportation charges prepaid. The instrument will be repaired and returned to the purchaser, transportation prepaid, unless the instrument is found to be damaged by misuse, in which case the instrument will be returned to the purchaser with repair and transportation billed.

This warranty, being the entire agreement between the parties, is given expressly and in place of all other express or implied warranties including implied warranties for merchantability or fitness for particular use.

NLS

Non-Linear Systems, Inc.

SHIPPING NOTICE / PACKING SLIP

NOTE: This completed form must accompany shipment.

Date ______________

Date of Original Purchase: ____/____ Mo. Yr.

Your Original P.O. No. ______________

CUSTOMER SHIP PRE-PAID TO:

NON-LINEAR SYSTEMS, INC.
533 STEVENS AVE.
SOLANA BEACH, CALIFORNIA 92075

NLS RETURN(FREIGHT PAID)TO:

____
____
____

Attn: ______________

When using window envelope, fold here.

Description of Instrument and Accessories Included:

Instrument Model No. ______	P/N ______	S/N ______
Accessories ______	P/N ______	S/N ______
______	P/N ______	S/N ______
______	P/N ______	S/N ______
______	P/N ______	S/N ______
______	P/N ______	S/N ______
______	P/N ______	S/N ______
______	P/N ______	S/N ______

Reason for Return (specify malfunctions in detail):

____
____
____
____
____
____
____
____
____
____
____

NLS Form 200-50

NOTICE

If at any time it should become necessary to return an NLS instrument to the factory, follow the instructions contained in the Appendix of this manual (page A-1) and utilize NLS Form No. 200-50 (Shipping Notice/Packing Slip), located at the rear of the manual.